Chemical Engineering

A McGRAW-HILL PUBLICATION

JULY 28, 1958

Published every-other-Monday

Seventy-five cents

DOES YOUR EMPLOYER OWN YOUR KNOWLEDGE?

WHO OWNS WHAT YOU KNOW?

COST COMPARISONS COMPARED

OPERATIONS AND MAINTENANCE

SEE PAGE TWO

seals tight

without valve damage

How you cut costs with the new

TUBE-TURN® LIGHT WEIGHT TAPER FACE FLANGES

The new TUBE-TURN* 125 lb. light weight, forged steel, taper face welding neck flanges (patent pending) can cut costs three ways:

1. You eliminate the hazard of breaking cast iron and semi-steel valves, fittings and equipment such as pumps and compressors, caused by overstressing the bolts to get a tight seal when regular ASA steel flanges are used.
2. You avoid the necessity of using more expensive 250 lb. valves with 300 lb. companion flanges.
3. The new flanges cost less, weigh less and take less storage space than the 150 lb. flanges they replace.

Maximum service pressures are the same as for Class 125 cast iron flanges in ASA B16.1, namely: 125 psi (gage) saturated steam; 175 psi (gage) liquid and gas (WOG) at 150°F.

Here is another example of the cost-saving advantages you realize when you specify TUBE-TURN products and buy them from your nearby Tube Turns' Distributor.

TUBE TURNS Louisville 1, Kentucky

DIVISION OF CHEMETRON CORPORATION

CHEMETRON

tt TUBE-TURN

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JULY 28, 1958

JOHN R. CALLAHAM, Editor-in-Chief

More for the Plant Man

On January 13 I told you about our plans to make the "new" biweekly CE more useful to chemical engineers in all functions.

On April 7 we started a new department—Design Notebook—specifically for men in design and development work.

On June 16 we began another new department—CE Cost File—for chemical engineers involved in cost estimation work.

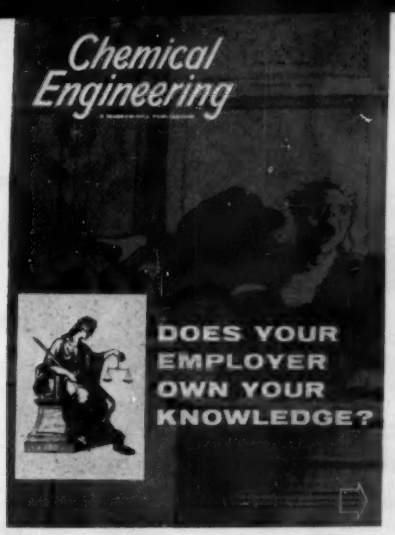
Now, in this issue, we start our third brand new department for 1958: Operation & Maintenance. This new section (at present on an every-other-issue basis) is aimed squarely at the plant man . . .

O & M will deal with the special day-to-day problems of those engineers who supervise and manage the operation and maintenance of chemical processing plants.

This opens up a vast array of topics that range from administrative problems of organization and scheduling to startup and shutdown procedures, quality control, materials handling, training operators, disaster planning, safety and fire protection, specifying and purchasing raw materials, loading and unloading, in-plant storage, trouble shooting, plant service engineering, instrumentation and control testing, employee relations, cost control and reduction, maintenance scheduling, preventive maintenance . . .

Like many of CE's engineering departments, this new section will be built around a feature topic each month. But it will also carry helpful hints, kinks and shortcuts as well as appropriate news shorts.

Operation & Maintenance . . . a new and specialized service for the plant chemical engineer . . . begins on p. 132.



FIFTEENTH OF TWENTY-SIX ISSUES

15/26

GUIDED TOUR

What is confidential know-how? Who owns it? For how long?

All of us gain know-how while we're working at our jobs. And all of our collective engineering experience and know-how represents an investment on the part of our employers. Now the knotty question comes up: When employees accept new jobs, who's the legal owner of their know-how knowledge? (p. 127)

How to make graphs more useful

Graphs are one of your everyday working tools. But better understanding plus some new tricks and new kinds of paper can make them even more useful in correlating data and solving problems. (p. 109)

A new refresher series on corrosion

Corrosion's a three-headed monster that can eat away your equipment, endanger

Chemical

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GUIDED TOUR

your personnel and contaminate your product. CE's latest refresher will help you keep it under control. (p. 114)

Cost comparisons compared

Here's new proof that all the "exact" methods for making engineering cost comparisons give equivalent results. This permits you to make your choice of methods on the basis of convenience. (p. 116)

Six keys to pilot plant success

Equipment and safety are essential to the success of your pilot plant operations. Here's a six-point check list that will minimize delays, breakdowns and accidents when you're piloting. (p. 119)

Gas turbines as process equipment

Process applications for gas turbines are few and far between. But recognition of the worth of turbine exhaust-oxygen may change this picture. See how it upped efficiency in one case. (p. 123)

CE is edited for the engineer concerned with chemical operations, whatever his function . . . administration, production and plant operations, design and construction, research and development, sales and purchasing. More engineers subscribe to CE than to any other magazine in the field. Print order this issue:

47,540

Developments in Chemical Engineering

Practice of Chemical Engineering

Engineering

Vol. 65. No. 15

Other Regular Features

Reader Service

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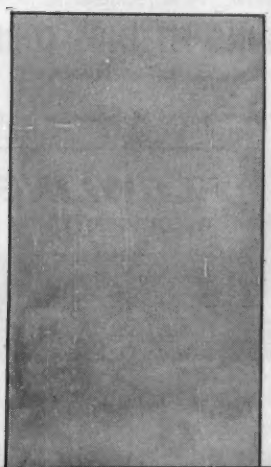
Chemical Engineering

This issue's top features of significance in

Petrochemicals & Petroleum Refining

JULY 28, 1958

Also of Basic Interest



Seamless fittings with all the plus values...at no extra cost

Your corrosion piping system can be designed better, assembled faster, made light and tight by using *FLOWLINE* fittings, butt-welded to straight-cut pipe. Available from stock through leading distributors. Made in sizes ½" through 12" — Schedules 5S, 10S, 40S, 80S — Stainless Types 304, 304L, 316, 347; Monel, Nickel, Aluminum.

WELDING FITTINGS CORP.

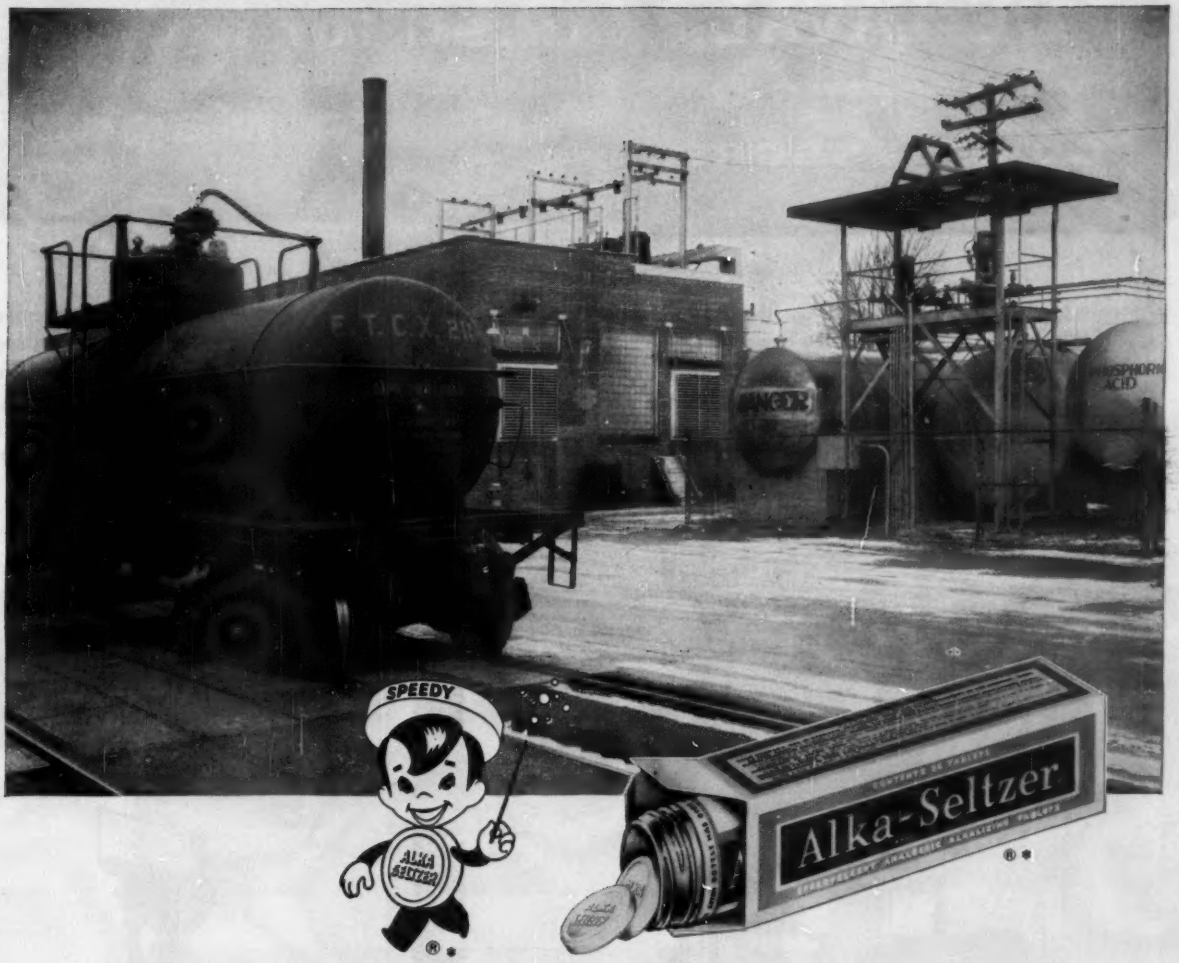
NEW CASTLE, PENNSYLVANIA

World's Largest Manufacturer of Stainless Welding Fittings

Remember **FLOWLINE®** WELDING FITTINGS

Forget CORROSION PIPING PROBLEMS

W-9.



NO HEADACHES HERE

Miles Laboratories, Inc. have relieved untold millions of headaches with their familiar Alka-Seltzer* tablets, but they have no headaches of their own in handling the considerable quantities of acetic anhydride and phosphoric acid required in their operations. This job is done by the two LaBour Type G pumps seen in the photograph.

These pumps unload tank cars as shown, or tank trucks on the paved area, and also move liquid to process from the storage tanks. They've delivered a combined total of 19 years of dependable service, without one minute of unscheduled time out. "They've never let us down," say the Miles people.

In the picture, note that the car is being unloaded through pipes under the pavement. During operation these are under less than atmospheric pressure, so there can be no loss of liquid. The packingless Type G's can't leak, either, and their only maintenance requirement is routine lubrication.

If you want dependable pump service without headaches, take a tip from the headache experts and specify LaBour.

*Alka-Seltzer and the "Speedy" figure are registered trademarks of Miles Laboratories, Inc., Elkhart, Ind.

ORIGINAL MANUFACTURERS OF THE SELF PRIMING CENTRIFUGAL PUMP

LABOUR

THE LaBOUR COMPANY, INC. • ELKHART, INDIANA, U. S. A.

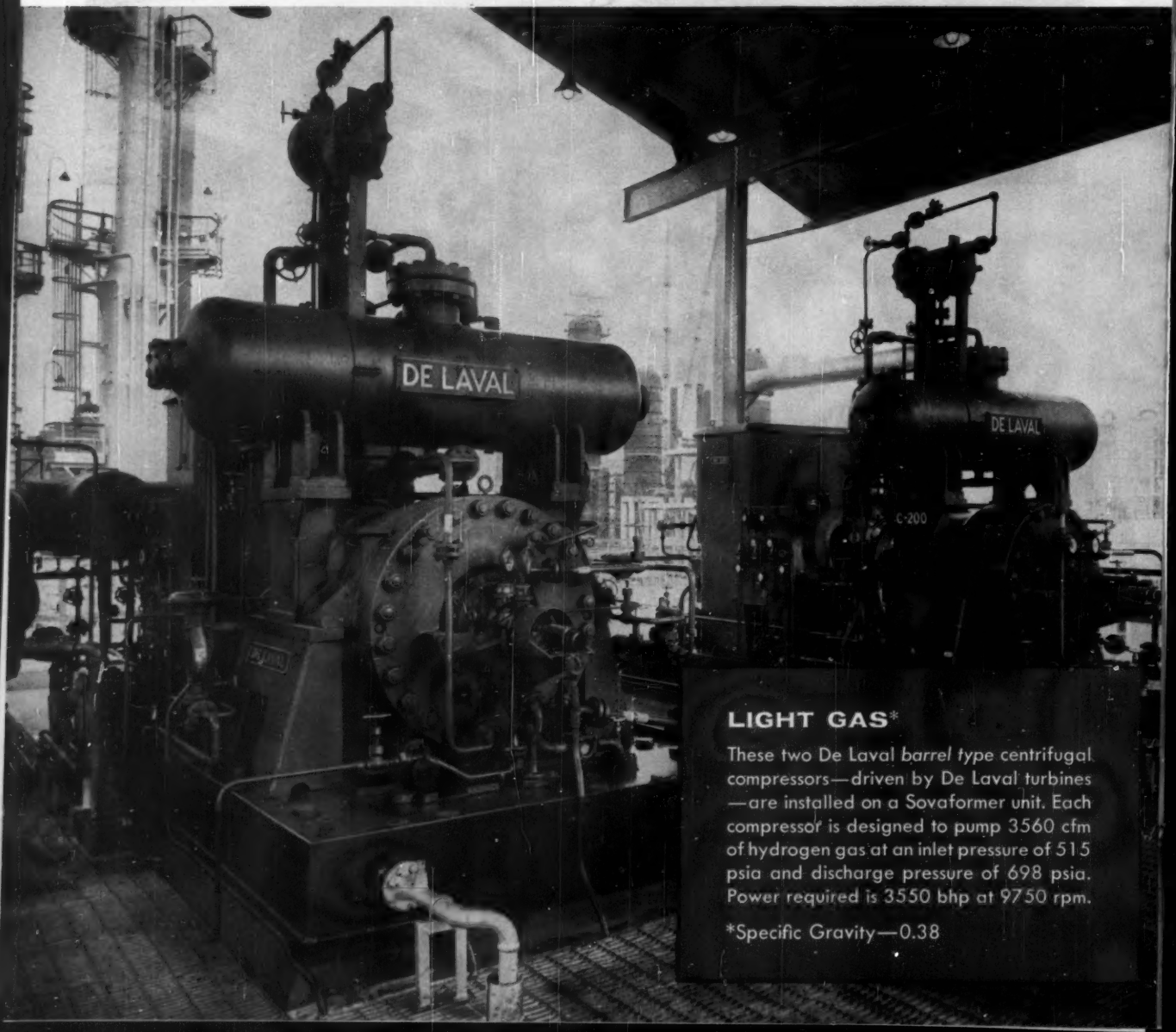
DE LAVAL CENTRIFUGAL COMPRESSORS used for light gas, in Magnolia

As part of the expansion program in the Beaumont, Texas refinery of the Magnolia Petroleum Company, De Laval turbine-driven centrifugal compressors are on stream in three important applications:

- **recirculating hydrogen gas in a reforming unit**
- **pumping hydrocarbon gas in a compressor station**
- **supplying combustion air on a giant cat cracker**

Designed and built to perform dependably in heavy-duty continuous operation, De Laval centrifugal compressors are available for every refinery process. Whether you need to handle light or heavy gases at high or low pressures in catalytic cracking, reforming, alkylation, coking or any similar service, it pays to look to De Laval. We can give you the benefit of more than 40 years of experience in solving gas compression problems.

SEND FOR DE LAVAL BULLETIN 0504.

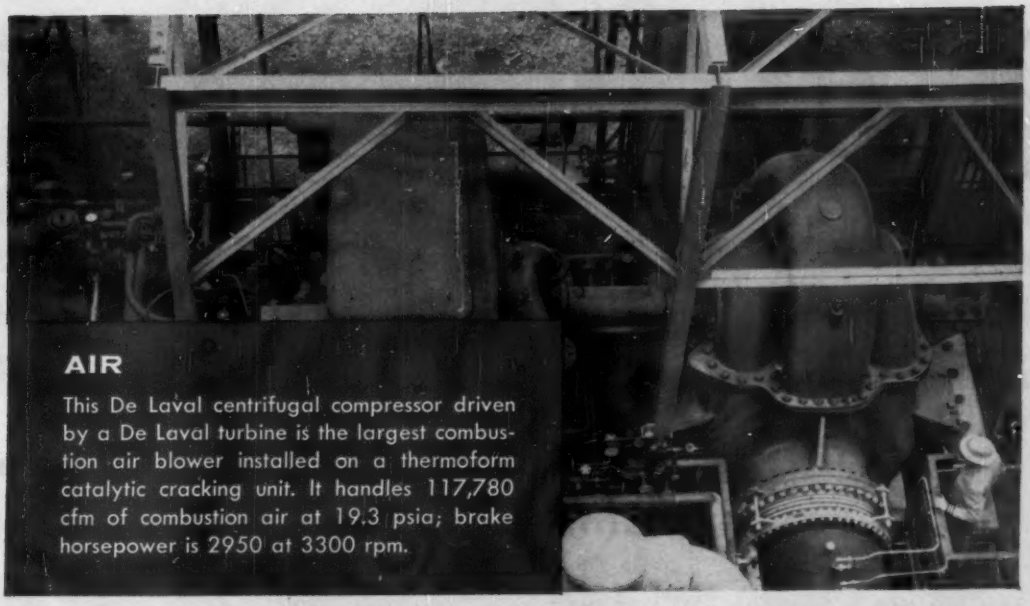


LIGHT GAS*

These two De Laval *barrel type* centrifugal compressors—driven by De Laval turbines—are installed on a Sovaformer unit. Each compressor is designed to pump 3560 cfm of hydrogen gas at an inlet pressure of 515 psia and discharge pressure of 698 psia. Power required is 3550 bhp at 9750 rpm.

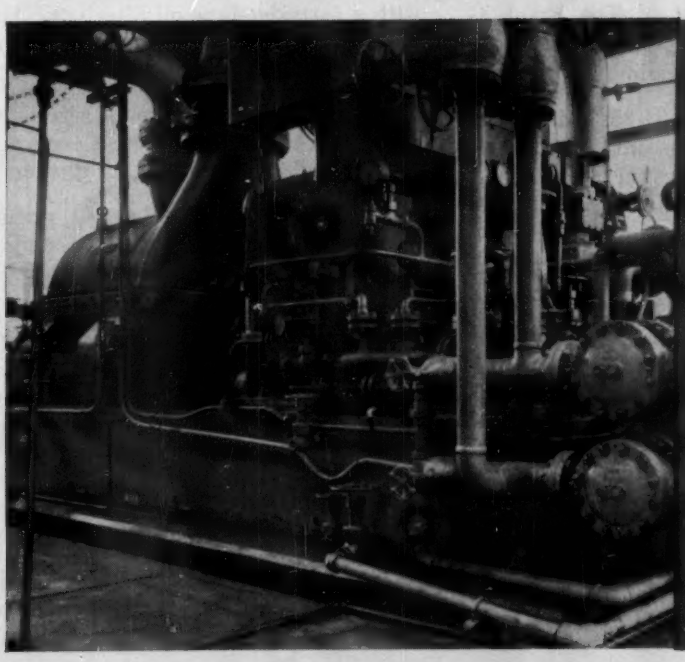
*Specific Gravity—0.38

heavy gas and air handling
Petroleum's expansion program



AIR

This De Laval centrifugal compressor driven by a De Laval turbine is the largest combustion air blower installed on a thermoform catalytic cracking unit. It handles 117,780 cfm of combustion air at 19.3 psia; brake horsepower is 2950 at 3300 rpm.



HEAVY GAS*

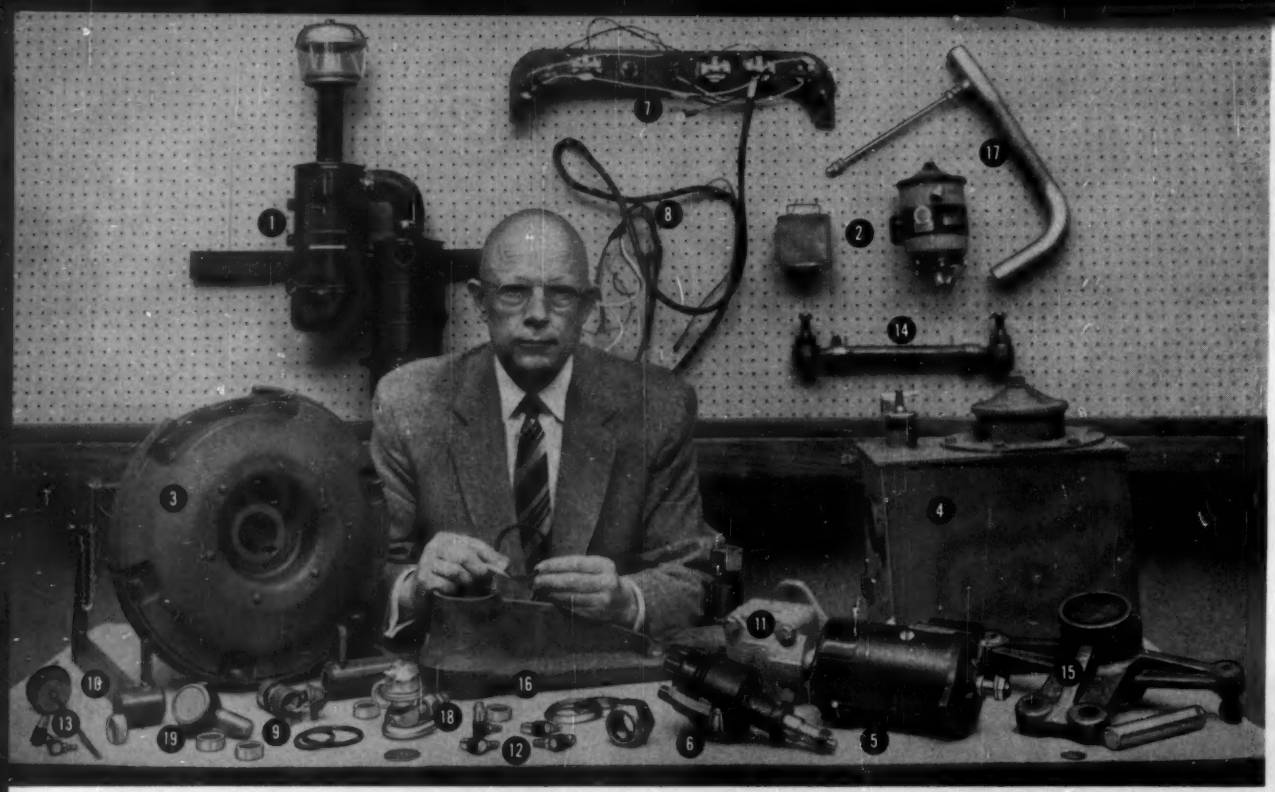
This De Laval centrifugal compressor and turbine installation is located in Magnolia Petroleum's number 1 gas compressor station. The unit is designed to pump 10,560 cfm of hydrocarbon gas at 65.0 psia with a suction pressure of 14.0 psia.

* Specific Gravity—1.376

DE LAVAL *Centrifugal Compressors*

DE LAVAL STEAM TURBINE COMPANY
803 Nottingham Way, Trenton 2, New Jersey

DL-419



"Why are so many PROTECTIVE features engineered into the new H-25 PAYLOADER?"

This question is frequently asked of Ralph Beyerstedt, Executive Vice President of The Frank G. Hough Co. because of his more than twenty years of experience in charge of engineering.

"During the development of the H-25," Mr. Beyerstedt explained, "as soon as it became evident that we were going to obtain the increased capacity, production, ease of operation, speed and mobility we sought, our engineers then gave major attention to protective features for operational insurance against wear, maintenance, abuse, downtime and the like.

"The more than 10,000 small HA "PAYLOADER" tractor-shovels that we have produced for steel mills, foundries and chemical and fertilizer plants operate under conditions which continuously subject the machines to dust, dirt, powder and foreign materials.

"Because these are sources of major headaches for owners and operators," said Mr. Beyerstedt, "we have given extra special consideration to elimination of the problems they cause.

Dozens of Protective Features

"Starting with the *triple* air cleaning system (1) we have a precleaner and dual oil-bath air cleaners for engine intake, and crankcase breather tube (17).

"Next, each of the three oil systems is equipped with a cartridge-type oil filter (2). These take care of the engine oil, the hydraulic-system oil and the power-shift transmission and torque converter oil.

"The self-adjusting, hydraulic service brakes (3) are *sealed* and the parking brake is enclosed in the transmission and operates in oil for greater dependability.

"The reservoir (4) of the closed, pressure-controlled hydraulic system has built-in cartridge-type filter and *sealed* dip-stick."

In discussing the components of the electrical system, Mr. Beyerstedt said, "There is a 12-volt system with the battery grounded direct to the starter housing; a non-vented, *sealed* generator (5); *sealed* ignition distributor (6); shock-mounted instrument panel (7) with solder-coated terminals and a plastic-coated wiring harness (8); *sealed* circuit breaker together with *sealed* ignition and starter switches (9) plus clutch-pressure warning device (18).

"*Sealed* teflon bushings are used extensively throughout with brake and transmission disconnect mechanism (10) and valve control mechanism (11).

"These *sealed* ball joints (12) are used with gearshift linkage and *sealed* ball joints of a different size (13) are used with the accelerator linkage.

"The steering linkage uses *sealed* ball joints on the tie rods (14), and on the drag link (19). The steering bell crank (15) is *sealed*, also the spindle and kingpin assemblies.

"The boom arm mechanism has tapered roller bearings and dust covers on the bell cranks (16) and *sealed* mated bronze and steel bushings plus O-ring seals at all major pivot points."

Now, What About Production?

The carry capacity of the H-25 "PAYLOADER" is 2,500 lbs.—25% greater than has ever before been available in a tractor-shovel of its size and maneuverability, yet it easily loads and unloads box cars with narrow 6-foot doors. It is the only loader in its size range with *complete* power shift transmission—having 2 speed ranges forward and 2 in reverse. Powersteer is also standard so that operating speed and handling ease is most favorable to all-out production all day without operator fatigue.

Other plus features of the H-25 that mean more production, less maintenance and longer life are the exclusive power-transfer differential, wet-sleeve overhead valve engine, full-shift fuel capacity, 4,500 lbs. of bucket breakout force and 40° bucket tip-back at ground level.

Your "PAYLOADER" Distributor wants to show you how the greater capacity, speed and handling ease of the H-25 can cut your bulk-handling costs. Ask him about Hough Purchase and Lease Plans too. The Frank G. Hough Co., 754 Sunnyside Ave., Libertyville, Ill.

8-A-2

Modern Materials Handling Equipment

THE FRANK G. HOUGH CO.

LIBERTYVILLE, ILLINOIS

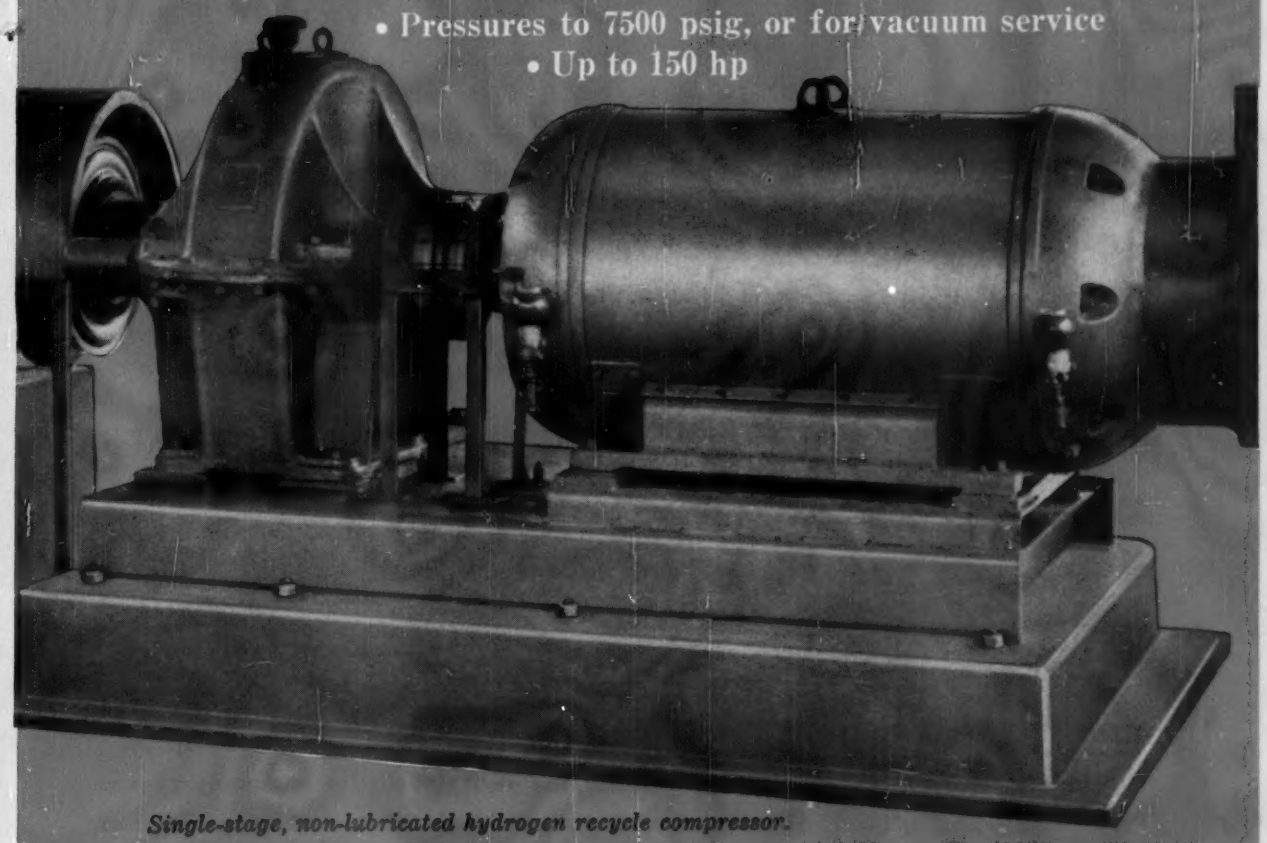
SUBSIDIARY—INTERNATIONAL HARVESTER COMPANY

The H-25 "PAYLOADER" is effectively shielded against dust, dirt and foreign materials by dozens of protective components.

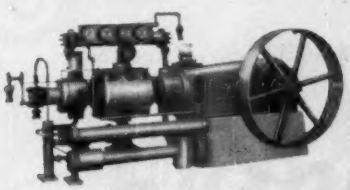
Class T

PROCESS COMPRESSORS

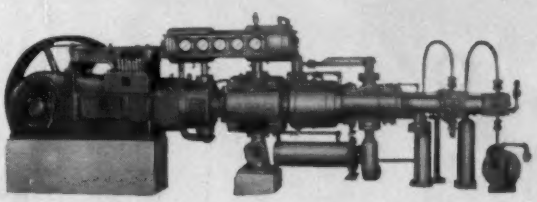
- Pressures to 7500 psig, or for vacuum service
- Up to 150 hp



Single-stage, non-lubricated hydrogen recycle compressor.



TCB-4 four-stage, straight-line compressor suitable for 6,000 lbs. discharge pressure.



Five-stage compressor designed for 7,500 lbs. service.

Greater Capacity . . .

. . . Higher Pressures

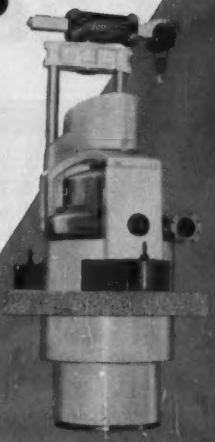
for Solids Dewatering

SHARPLES ADVANCED DESIGN CENTRIFUGES

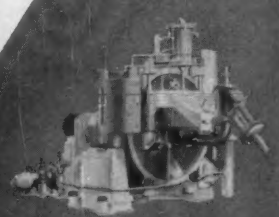
P-7000 SUPER-D-CANTER — The largest of six sizes of continuous scroll type solids discharge centrifuges for the clarification of crystalline or amorphous solids . . . The P-7000 will handle solids at rates in excess of 12-15 tons/hr. *For operation at pressures to 150 psi.*

SUPER-D-HYDRATORS — These high efficiency crystal drying centrifuges are available in 3 sizes, the largest of which has a capacity on ammonium sulphate in excess of 20 tons/hr. *For operation at pressures to 150 psi.*

DH-6 NOZLJECTOR — Designed to handle feeds in excess of 500 gallons per minute. This is the largest of 3 sizes of continuous solids discharge nozzle type centrifuges for the clarification and concentration of solids in slurries and sludges. *For operation at pressures to 150 psi.*



P-7000 VERTICAL SUPER-D-CANTER



SUPER-D-HYDRATOR for dewatering crystals

* The bowl (rotor) of a pressurized D-H6 NOZLJECTOR—the largest and highest capacity nozzle type centrifuge available to industry.

Sharples is setting new standards of capacity and all-round performance with the only really new centrifuges being offered today. If a solids dewatering step is necessary in your processing, it will pay you to get the facts from Sharples.

Your inquiry will be given our prompt attention.

SHARPLES

THE SHARPLES CORPORATION

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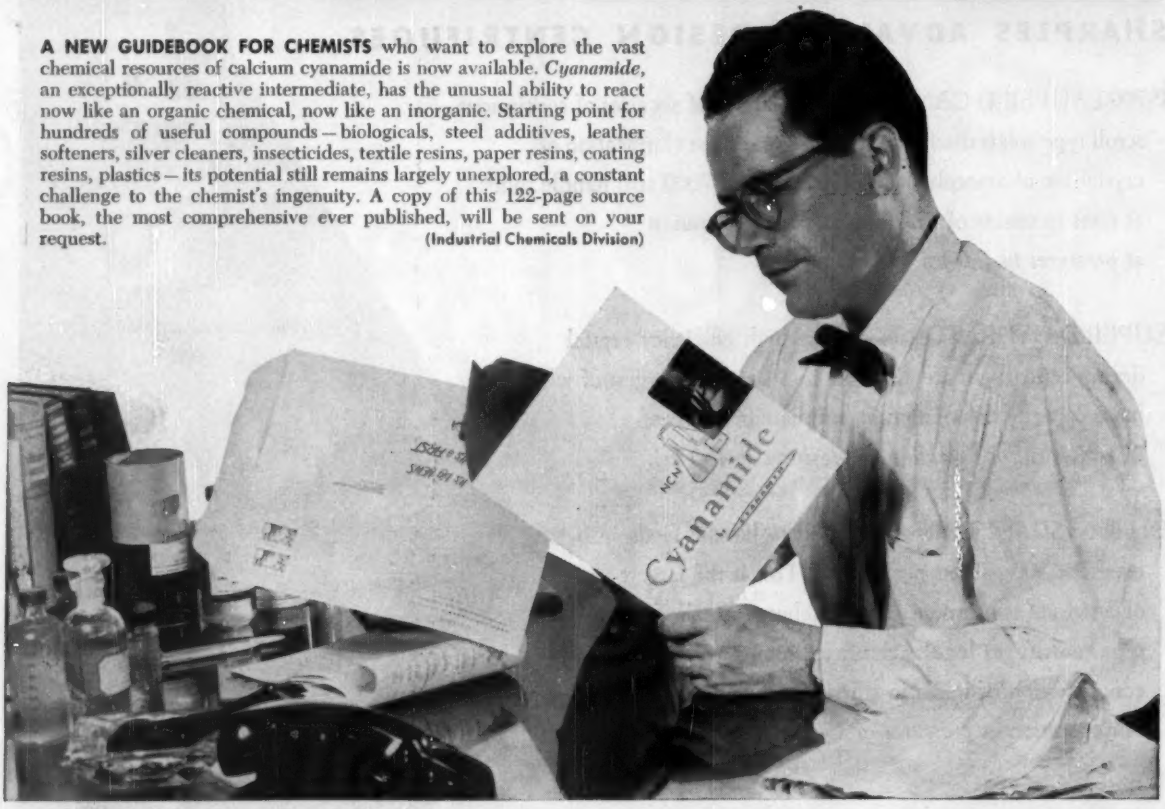
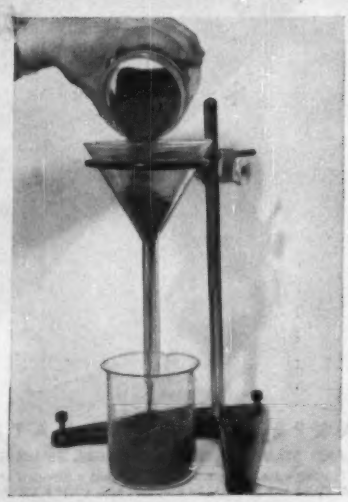
CYANAMID

Chemical Newsfront

A NEW GUIDEBOOK FOR CHEMISTS who want to explore the vast chemical resources of calcium cyanamide is now available. *Cyanamide*, an exceptionally reactive intermediate, has the unusual ability to react now like an organic chemical, now like an inorganic. Starting point for hundreds of useful compounds — biologicals, steel additives, leather softeners, silver cleaners, insecticides, textile resins, paper resins, coating resins, plastics — its potential still remains largely unexplored, a constant challenge to the chemist's ingenuity. A copy of this 122-page source book, the most comprehensive ever published, will be sent on your request. **(Industrial Chemicals Division)**





NOW DEVELOPED IN FLAKED FORM, N-cyclo-hexyl-benzothiazole-2-sulfenamide has been added to complete Cyanamid's line of rubber vulcanization accelerators. In this unique flaked form, CYDAC® *accelerator* eliminates caking often associated with currently available powders. Its free-flowing properties are of particular advantage in the automatic compounding of rubber for tire treads, footwear, heels, soles and similar products. Cyanamid's line now ranges from the very fast-curing mercaptobenzothiazole to the safest delayed-action DIBS® *accelerator*, with CYDAC falling between MBTS and NOBS® *accelerators* in processing safety. **(Organic Chemicals Division)**

FABRICS RECOVER QUICKLY FROM WRINKLES when treated with new AEROTEX* *Resin 23*, one of Cyanamid's minimum-care textile finishes. Cottons or rayons are stabilized or "set" through impregnation and curing of the resin. Even after repeated launderings, treated fabric springs back to its original position, requiring only "touch-up" ironing. Exceptional wrinkle resistance is combined with high tensile strength and resistance to discoloration from chlorine bleaches and ultraviolet rays. AEROTEX Resin 23 imparts a soft hand, and may be used with other finishes to give fabrics other desirable properties.

(Organic Chemicals Division)

NEED A GELLING AGENT? Gels from low viscosity systems can now be produced by AM-9* *gelling agent*. AM-9 forms a nonviscous solution in water. After the addition of a catalyst, the solution gels in a predetermined period of time which is controlled by the amount of catalyst used. Viscosity of the solution remains essentially that of water until just before the gel is formed. In the example above, sand is being added to AM-9 to illustrate this effect. The gel formed is insoluble in water, organic solvents and alkali. The AM-9 gel is impermeable to water and most organic solvents. The gel is resistant to fungal attack and is mechanically stable in contact with water. We will be glad to send a technical bulletin on your request.

(Market Development Department)

PHOSPHORIC ACID IS NOW ON TAP at Cyanamid's new triple superphosphate plant at Brewster, Florida. A wet process *phosphoric acid*— 54% P_2O_5— it offers the fertilizer industry an economical way to produce high analysis mixed goods using less expensive nitrogens and less sulfuric acid in processing. It will enable fertilizer manufacturers to meet farmers' constantly increasing demands for high analysis plant food. Further information is available on your request.

(Agricultural Division)

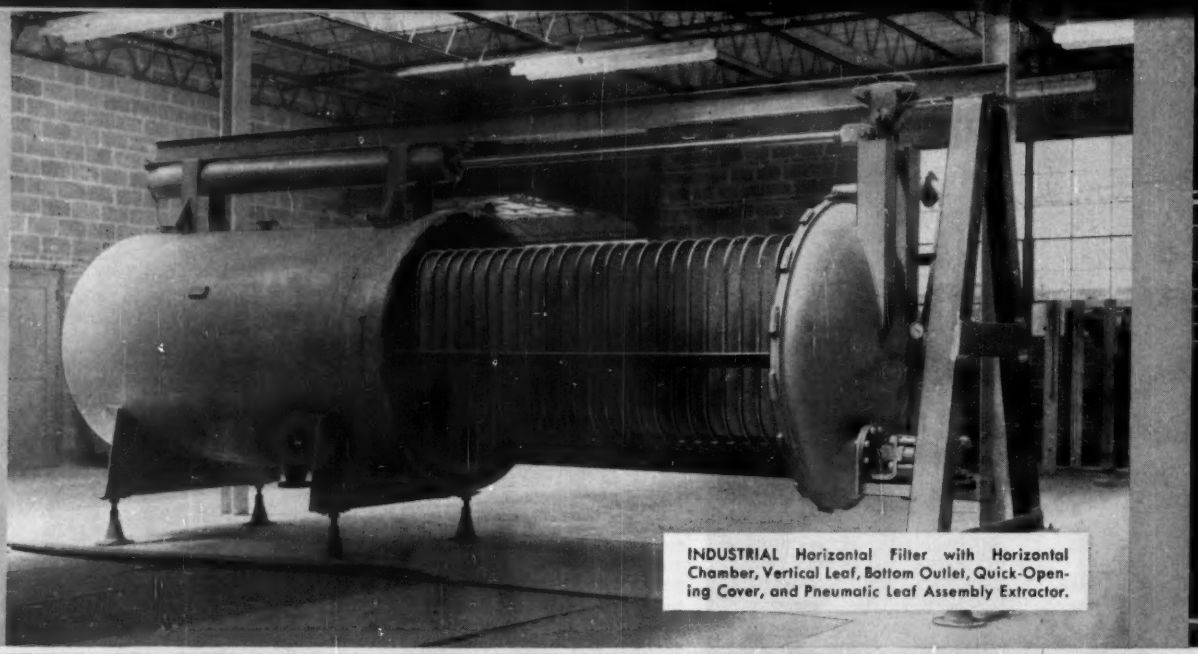
*Trademark

CYANAMID

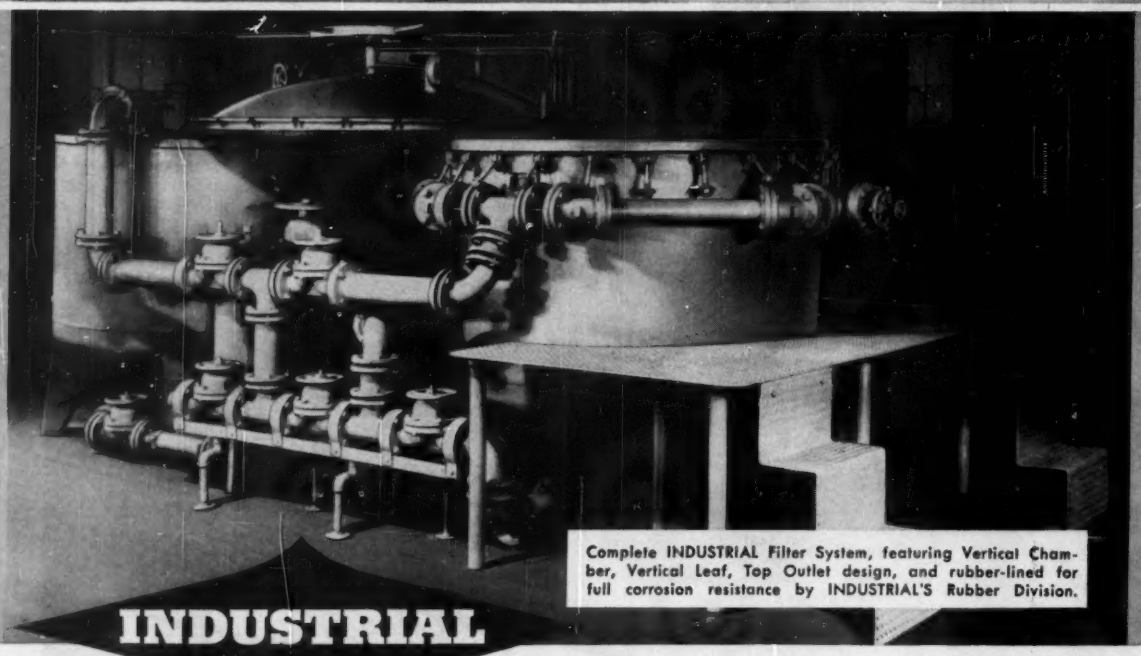
AMERICAN CYANAMID COMPANY

30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

For further information on these and other chemicals, call, write or wire American Cyanamid Company



INDUSTRIAL Horizontal Filter with Horizontal Chamber, Vertical Leaf, Bottom Outlet, Quick-Opening Cover, and Pneumatic Leaf Assembly Extractor.



Complete INDUSTRIAL Filter System, featuring Vertical Chamber, Vertical Leaf, Top Outlet design, and rubber-lined for full corrosion resistance by INDUSTRIAL'S Rubber Division.

INDUSTRIAL

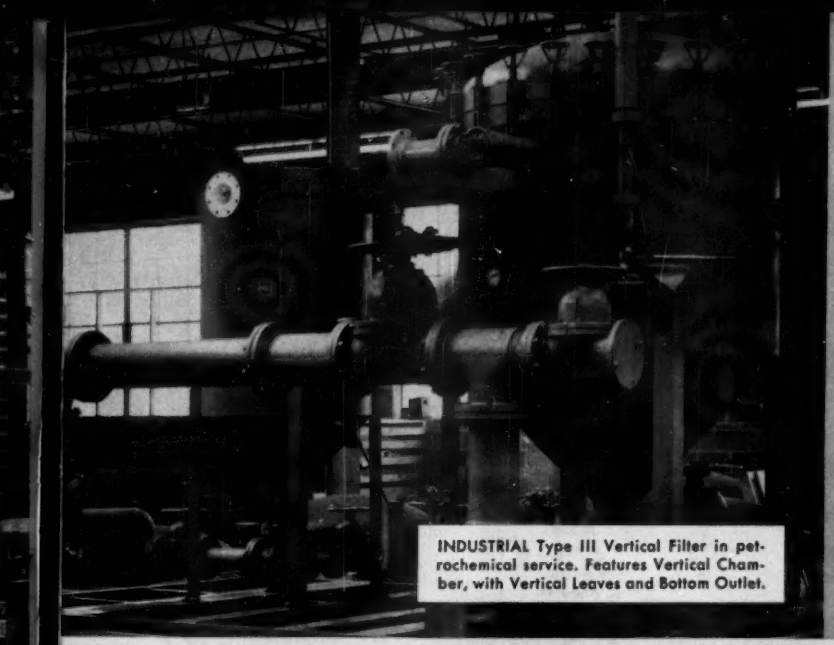
Engineered Filtration Equipment and Techniques to improve product quality—cut processing costs

Your process is different in some ways from any other. That's why—for highest product quality, operating simplicity, and economy—you need a filtration system built specifically for you. An INDUSTRIAL *engineered* system is exactly that.

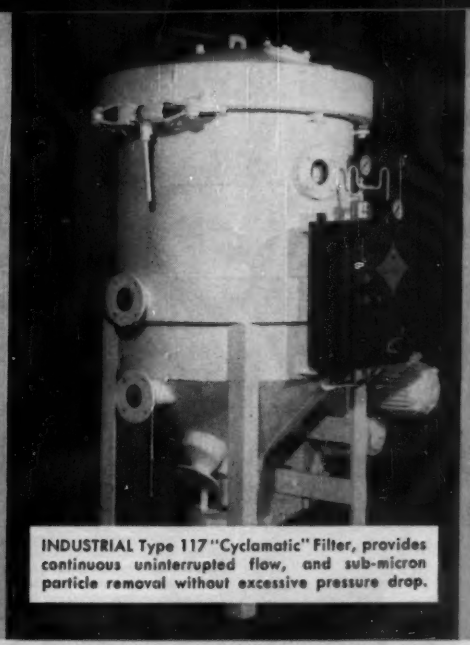
INDUSTRIAL is more than a builder of filtration equipment—it's a specialized engineering service that makes available to you over 25 years of filtration experience and techniques. Our engineers and chemists will work with you to develop a system which takes into consideration all the factors vital to your specific operation—type of slurry, filter design, cake recovery, cleaning, piping, auxiliary apparatus, and controls. At INDUSTRIAL'S Testing Center, there are complete facilities for pilot plant study of any system, ready to be put to work for you.

Remember, too, that INDUSTRIAL produces a full range of filter types and sizes—and can therefore recommend, without partiality, a filter most suitable for your needs. A wide variety of cost-saving optional features are also available. And all systems are adaptable to full or partial automation.

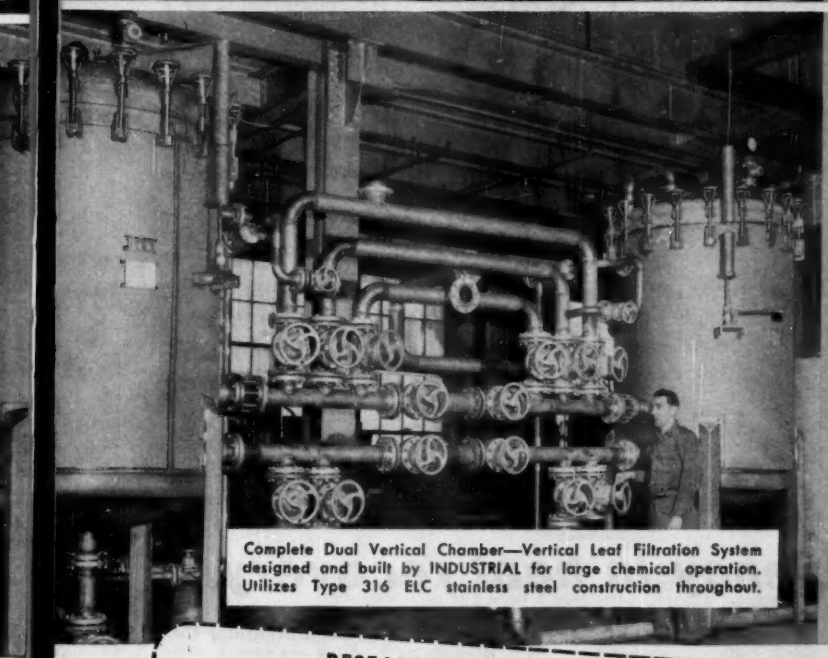
Call or write INDUSTRIAL to find out how properly-engineered filtration equipment and techniques can improve product quality and cut processing costs.



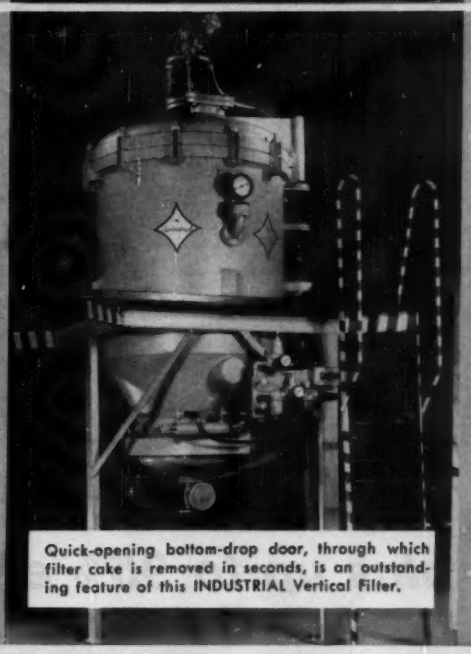
INDUSTRIAL Type III Vertical Filter in petrochemical service. Features Vertical Chamber, with Vertical Leaves and Bottom Outlet.



INDUSTRIAL Type 117 "Cyclamatic" Filter, provides continuous uninterrupted flow, and sub-micron particle removal without excessive pressure drop.

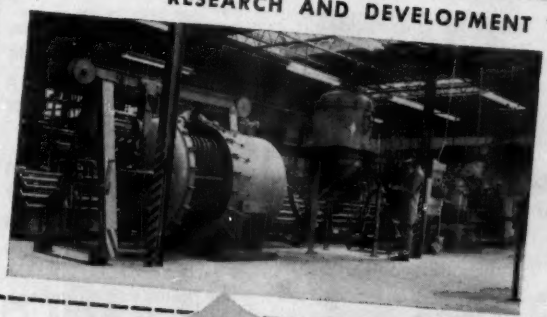


Complete Dual Vertical Chamber—Vertical Leaf Filtration System designed and built by INDUSTRIAL for large chemical operation. Utilizes Type 316 ELC stainless steel construction throughout.

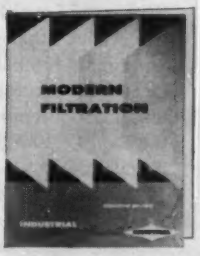


Quick-opening bottom-drop door, through which filter cake is removed in seconds, is an outstanding feature of this INDUSTRIAL Vertical Filter.

RESEARCH AND DEVELOPMENT TESTING CENTER



Here, your process conditions can be duplicated and studied —to help you select the most suitable filtration system, without disturbing your production. This Center includes all types of pressure filters and auxiliary equipment—all interconnected by an ingenious valve and piping system. Comparative data on variations is obtained in minutes, instead of days of costly experimentation in your own plant.



Write today for descriptive literature and recommendations on INDUSTRIAL equipment to meet your specific requirements.

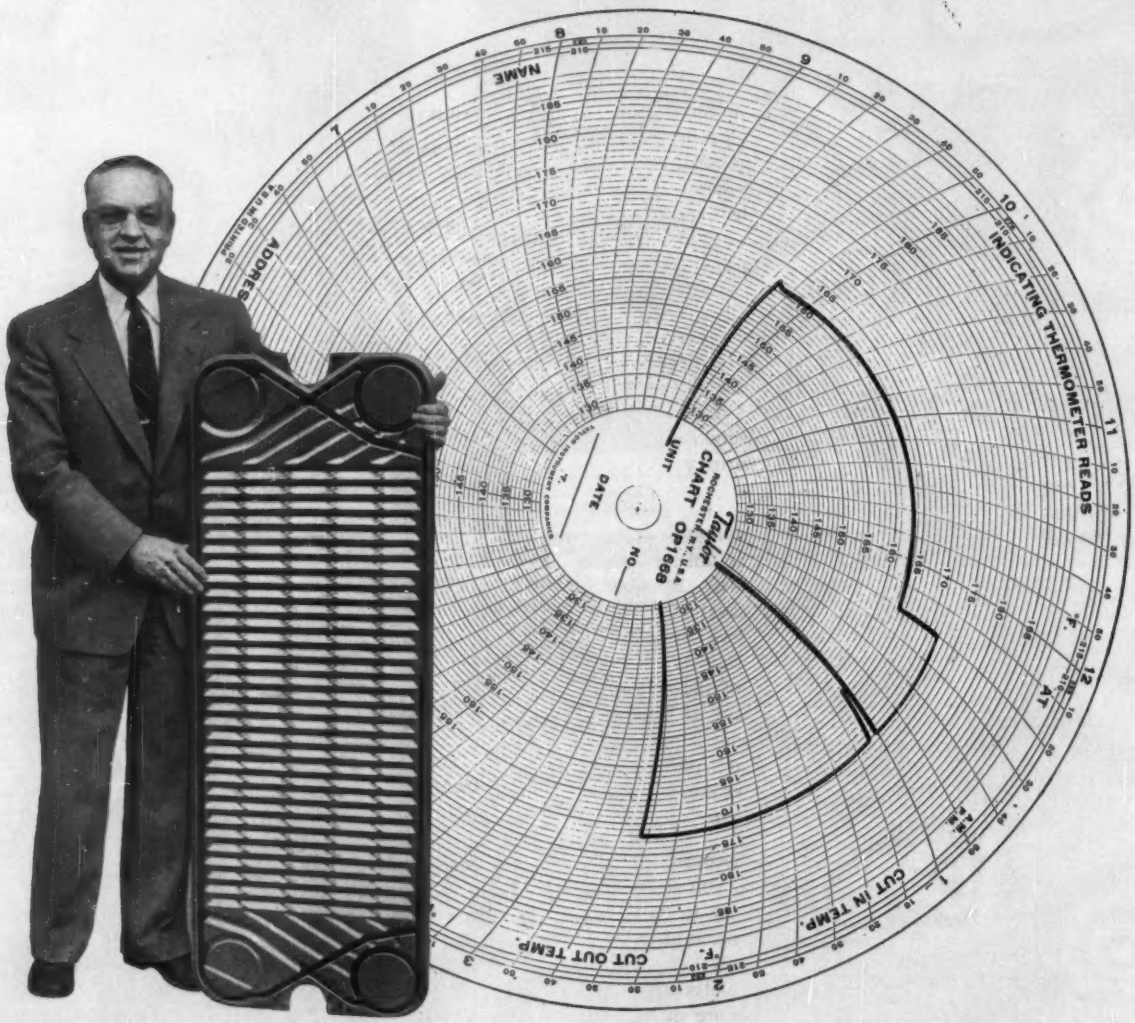
C358

INDUSTRIAL

INDUSTRIAL FILTER & PUMP MFG. CO.

5918 Ogden Avenue, Chicago 50, Illinois

PRESSURE FILTERS ◆ ION EXCHANGE EQUIPMENT ◆ WASTE-TREATING EQUIPMENT



"Pinpoint accuracy in temperature control... plus up to 95% efficiency in heat recovery."

Fred Wheelwright, De Laval Separator Co.

With a De Laval Plate Heat Exchanger, you can recover process heat that you're now wasting and incorporate it as a highly profitable supplement to your heating system. Or, if your process requires pinpoint accuracy in controlling product temperature over sustained periods of time, the De Laval unit holds the temperature precisely where it's supposed to be . . . no "seeking" or time-lag. The De Laval unit equipped with the exclusive Vacuum Steam Heating System responds immediately to pre-set temperature changes and holds the required temperature to within 1° for as long as you want it.

Simplicity is the key: The assembled unit is a simple device. Plates like the one I'm holding in the illustration are assembled on two carrying bars between a holding frame. The product flows continuously in the space between alternate plates, and the heating or cooling medium flows countercurrent between the adjacent spaces. The plates are closely spaced so the liquids flow in thin layers, and they are corrugated so that the flow is of a high turbulence. These two factors make heat transfer rapid and uniform.

Easy to install: You can install a De Laval Plate Heat Exchanger in any available, convenient spot in your plant. It requires a minimum of space, and the unit is shipped completely assembled. All you do is add pumps, piping and controls and the unit is ready to operate. Since heat transfer and connecting plates can be individually added or removed, the system can be easily rearranged at any time to perform any or all of its functions . . . heating, cooling or heat transfer.

Custom-tailored units: The savings you realize with a De Laval Plate Heat Exchanger start from the moment

of purchase. You're getting custom equipment without paying custom prices. As soon as we get your process data, our engineers draw up the specifications for a unit tailor-made to fit your needs. They select from ten basic frames according to capacity, content and function, and calculate the correct number and arrangement of plates. The unit is custom assembled and tested at our factory before shipment to you.

Pinpoint temperature control: You can maintain as little as 3° temperature differential between product and heating or cooling medium in a De Laval unit. It not only gives maximum utilization of heating/cooling medium, it also gives complete protection against thermal shock and burn-on. Product uniformity and purity are 100% protected.

For example: As every connoisseur knows, wine may lose its natural flavor or bouquet unless temperature stabilization is carefully controlled. Roma Winery, Fresno, California, uses a De Laval Plate Heat Exchanger in three sections to achieve complete control of temperature changes in processing its fine products. The wine enters the first section of the exchanger and is cooled as it flows countercurrent to brine or other coolant; in the next section, the wine is pre-heated as it passes wine flowing countercurrent from the third section where it has been heated under precision control to the exact temperature required in the process.

Easy to clean: When cleaning is necessary, it's a simple matter. Under most circumstances, you simply circulate a cleaning solution at high velocity to clean the unit thoroughly. When manual cleaning is desired, it still takes only a few minutes. By simply loosening the two tightening end nuts and sliding the plates along the carrying bar, all heat transfer surfaces are quickly exposed for hosing or hand brushing and visual inspection. Slide the plates back together, tighten the end nuts, and the unit is ready to operate again.

Corrosion control: The plate I'm holding illustrates some of the corrosion control features of the plate heat exchanger. The heat transfer plates are made in either type 304 or 316 heavy-gauge stainless steel—both types of .049 inch thickness. The use of stainless steel permits the processing of many corrosive liquids. Further, the high velocity and great turbulence of liquids processed in the plate heat exchanger tend to discourage corrosion by preventing any settling. And the plates are easy to clean as noted above.

A case in point: The Wisconsin Rapids plant of Consolidated Water Power and Paper Company had trouble keeping its log soaking pond at the required temperature, especially during the cold months. They'd been blowing live steam into the pond, a system which was both costly and inefficient.

Now, with a De Laval Plate Heat Exchanger, they recover 10,800,000 BTU per hour from spent sulphite liquor, all of which had been going to waste previously. They maintain the water temperature in the pond at a constant 91°F. by continuous recirculation through one section of the exchanger, handling 288,000 lbs. of water per hour.

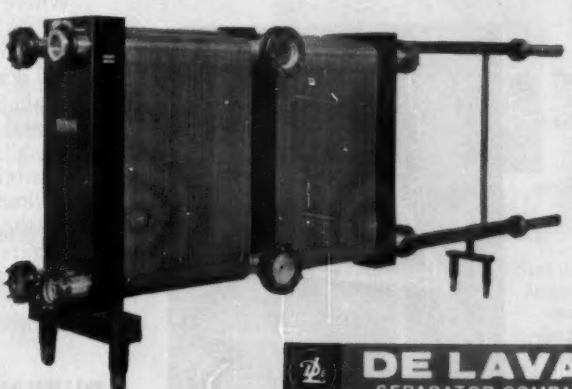
Another section of the exchanger uses recaptured heat from the same source to pre-heat 45,000 lbs. of process water per hour from 34°F. to 138°F.

The unit doing this remarkable job with the highly corrosive spent sulphite liquor is also remarkably small . . . only 96-inches long, 72-inches high and 33-inches wide.

SEND FOR YOUR FREE COPY OF OUR ILLUSTRATED BOOKLET NO. S. A1067 ON THE DE LAVAL PLATE HEAT EXCHANGER. MORE DETAILS AND SPECIFIC EXAMPLES OF BETTER PROCESS CONTROL AND PROFITABLE HEAT RECOVERY. DROP US A LINE ON YOUR LETTERHEAD.

COMPACT Requires roughly ¼ the heat transfer surface of a shell & tube unit.

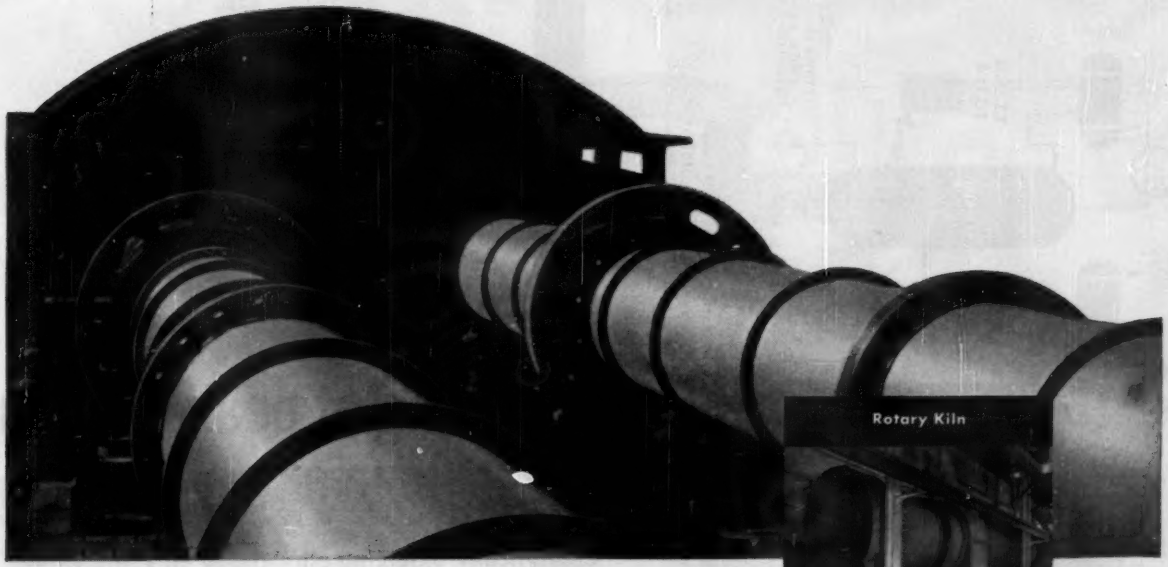
EASY TO CLEAN Loosening two end-nuts quickly exposes all heat transfer surfaces . . . broad and flat for rapid cleaning.

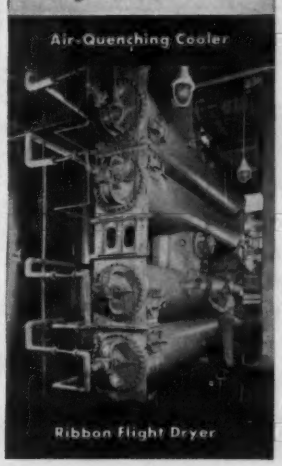


DE LAVAL
SEPARATOR COMPANY

THE DE LAVAL SEPARATOR COMPANY
Poughkeepsie, New York
or 427 Randolph Street, Chicago 6, Illinois

DE LAVAL PACIFIC COMPANY,
201 E. Millbrae Avenue, Millbrae, Calif.





Heat Transfer Efficiency

...depends on more than equipment

AN array of even the best heat transfer equipment isn't enough. To increase production, lower processing costs and improve product quality, this equipment must be coordinated into an efficient flow design. Allis-Chalmers recommends equipment only after a detailed study of all processing factors.

Call in an A-C Engineering Team

Allis-Chalmers engineers concern themselves with the entire operation: the evaluation of variables . . . plant design . . . the integration of equipment into a complete process. A-C has complete facilities for pre-recommendation research, and pilot plant testing, if necessary.

Expert installation supervision and local field service are supplied by Allis-Chalmers. After installation, Allis-Chalmers provides periodic check-up, maintenance advice and, of course, fast parts service for the life of the equipment.

Ask your nearby A-C man for Bulletin 25C6177, or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin.

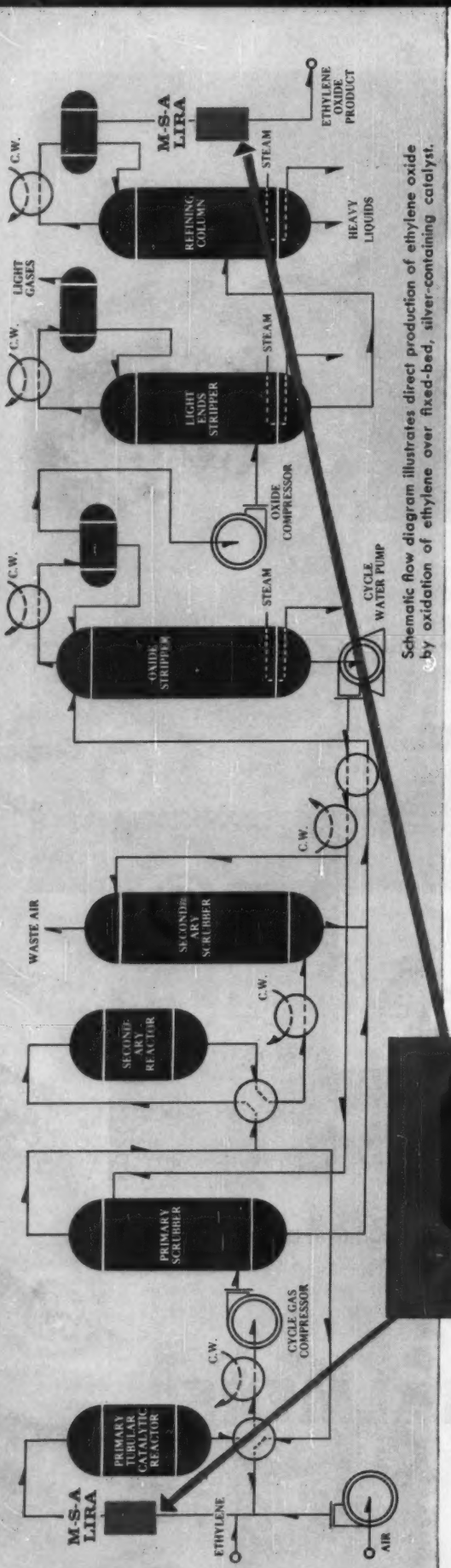
Partial list of material processed by A-C heat transfer equipment

Limestone	Alumina	Phosphates	Fuller's Earth
Lime	Bauxite	Refractories	Nickel Ore
Dolomite	Manganese Oxide	Foundry Sand	Copper
Magnesia	Iron Ore	Petroleum Coke	

A-C ALLIS-CHALMERS

ALLIS-CHALMERS

A-5692



Schematic flow diagram illustrates direct production of ethylene oxide by oxidation of ethylene over fixed-bed, silver-containing catalyst.

ANOTHER PROBLEM-SOLVING APPLICATION OF M-S-A® LIRA ANALYZERS:

helping to keep reactors operating at peak efficiency in ethylene oxide plants

Catalytically oxidizing ethylene to ethylene oxide? You can do it safer, at a greater rate, at less cost by measuring both ethylene input and ethylene oxide product with M-S-A LIRA Model 200 Infra-Red Analyzers

M-S-A LIRA Analyzers can save more than they cost in a matter of months. And they can contribute mightily toward bringing the plant to peak efficiency.

A striking example of this interesting claim is the use of Model 200 LIRA Analyzers in processing ethylene oxide by direct oxidation of ethylene. In this process, LIRAs are used to measure the ethylene in relation to the oxygen input into the reactor. This in turn assures peak operating efficiency of the reactor.

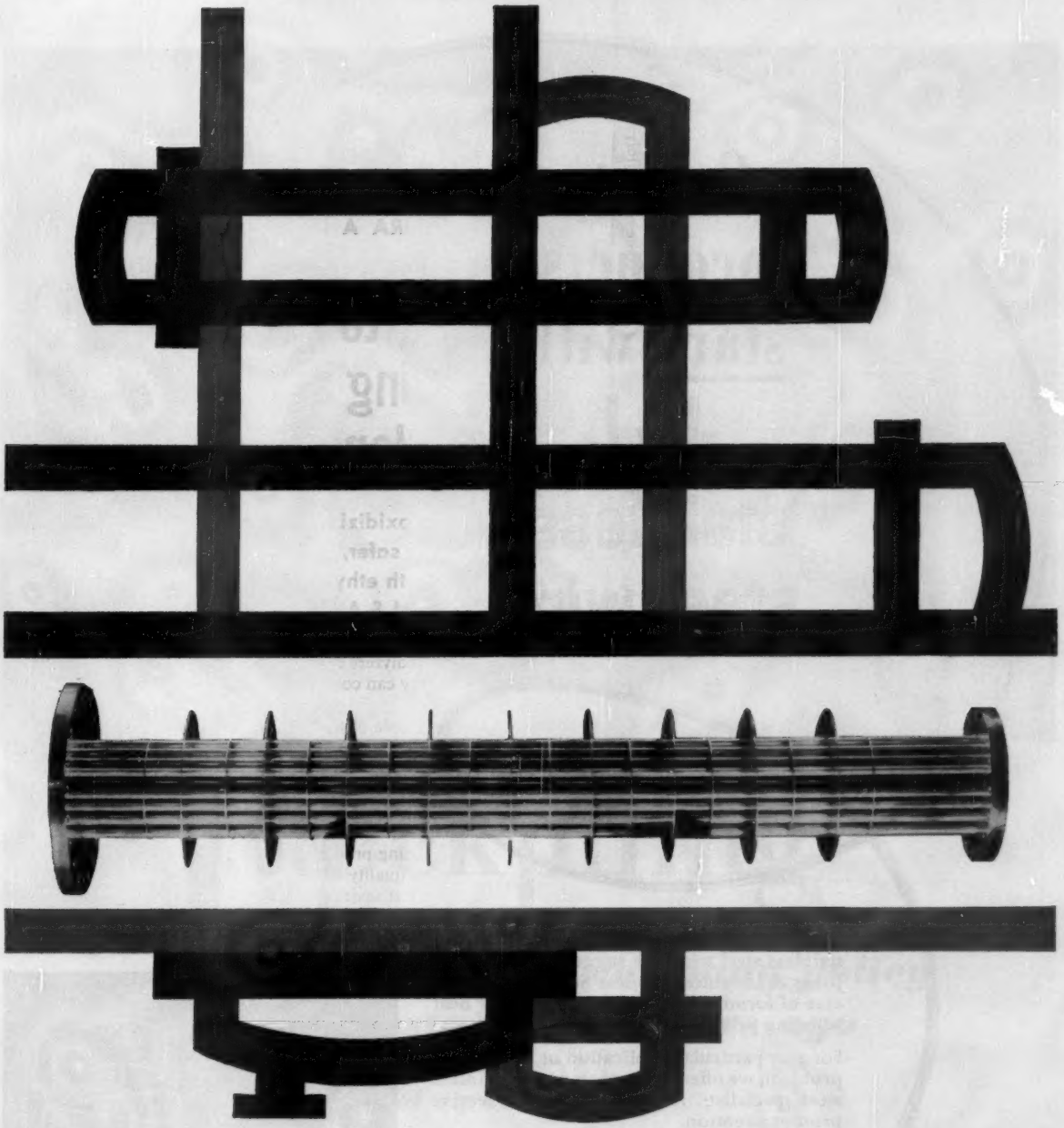
The Model 200 is also used in this process to measure the purity of ethylene oxide being produced as the final product. No need for manual tests for product quality. It's automatic. Continuous. And that's where some of the biggest savings lie. Let's face it: manpower used in process monitoring is expensive. So, let the LIRA do it.

An M-S-A Instrument Specialist will be happy to put our ingenuity to work on your process stream problems: safety, product quality, measurement or control. Consult him. Or write us for helpful literature.

Explosion-proof Model 200 has a tamper-proof lock. All self-checking circuit controls are easily accessible through the explosion-proof enclosure.

INSTRUMENT DIVISION

Mine Safety Appliances Company
Pittsburgh 8, Pennsylvania



win the fight against corrosion—with Alcoa Aluminum

Here's a $100-million example. The refining industry's requirements for heat exchanger tubes are 40 ft per barrel of capacity. Some 30 ft of this requirement involves exchanger applications in which Alcoa has proved aluminum is ideal. By using aluminum tubes in all those applications, the refining industry would have saved approximately $37 million in original capital investment. Capitalized at the refining industry's normal rate of return, that saving would be worth about $100 million over a 10-year operating period.

Don't shovel good money after bad by reinstalling unsuitable material. Over 30 years' experience in the process industries has given Alcoa engineers full knowledge of the aluminum alloys and installation methods by which corrosion can be eliminated. Put their knowledge to work for you. Outline your corrosion problems in a letter to ALUMINUM COMPANY OF AMERICA, 903-G Alcoa Building, Pittsburgh 19, Pa.

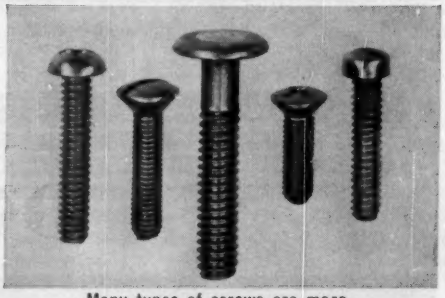
"ALCOA THEATRE"
Exciting Adventure
Alternate Monday Evenings

ALCOA CHEMICALS

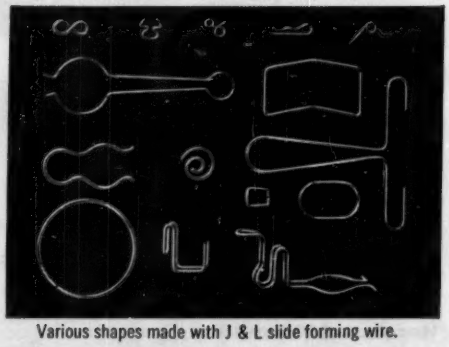
Specify Alcoa Aluminum for
corrosion-free Process Equipment
Pipe & Tube
Tanks, Containers, Trucks & Cars
Plant Structures

Quality products start with J&L stainless steel wire

Long-lasting filters and screens are woven from stainless steel wire.



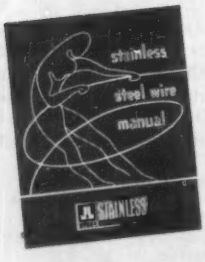
Many types of screws are more economically formed by cold heading.



Various shapes made with J & L slide forming wire.

Many types of products are fabricated from stainless steel wire. We suggest you consider Jones & Laughlin Stainless Steel Wire where ease of forming or special corrosion or heat resisting properties are required.

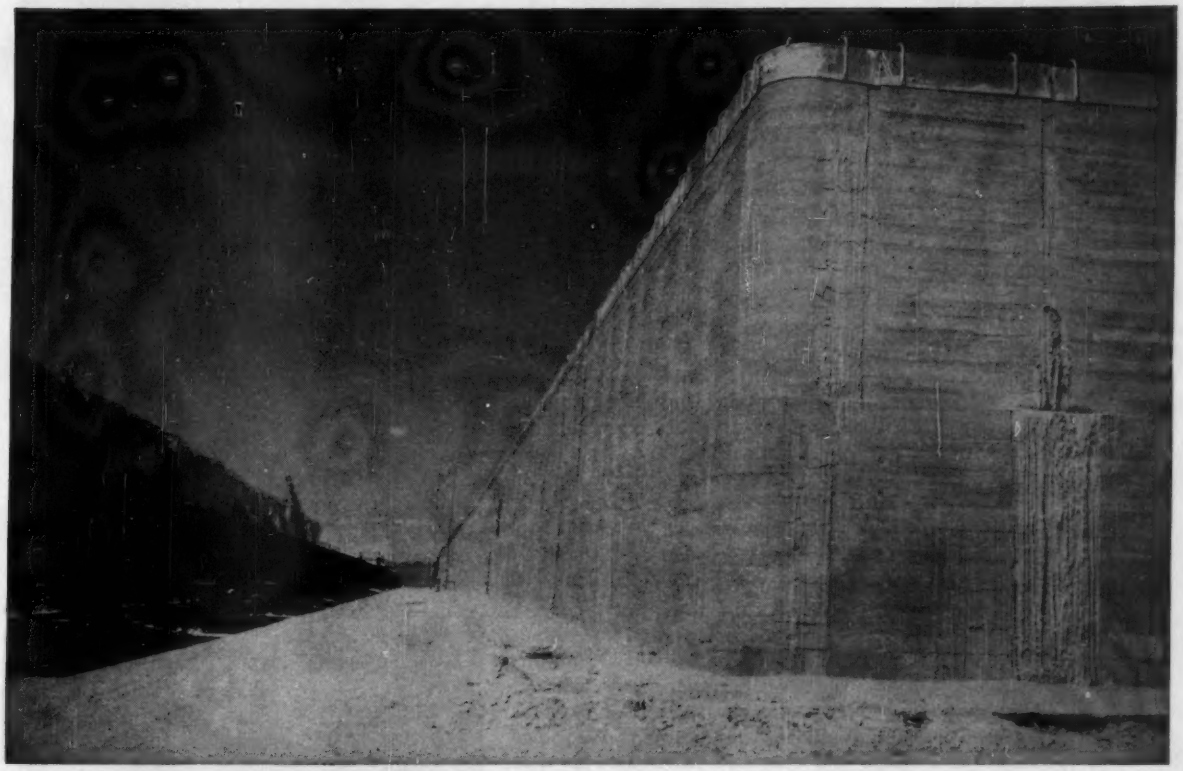
For *your* particular application or production problem, we offer the services of our stainless steel specialists. A letter or call will receive prompt attention.



Wire today for your copy of J & L's new Stainless Steel Wire Manual.

Improve your Products with . . .
J&L STEEL STAINLESS
BAR • WIRE • SHEET • STRIP

Jones & Laughlin Steel Corporation • STAINLESS STEEL DIVISION • Box 4606, Detroit 34



Stockpiling

...a continuing company policy established years ago

Stockpiling is a measure of service.

The government is stockpiling strategic materials for its long range defense program. Thus, it serves the citizenry. The producer of a raw material who as a company policy stockpiles also serves . . . serves its customers who in turn serve others by being able to count on a supply of the raw material in quantity.

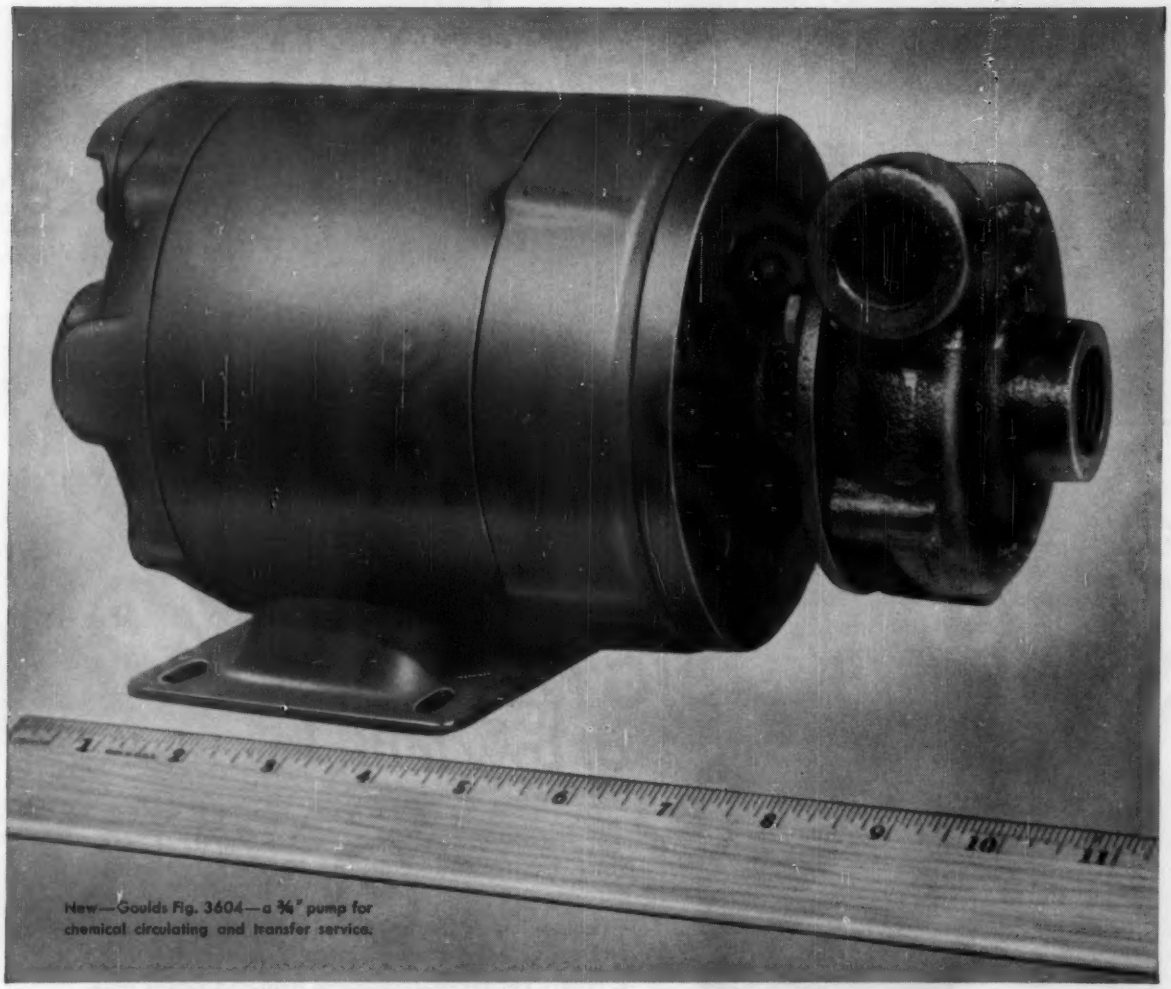
The policy of Texas Gulf Sulphur Company has always been to stockpile . . . always producing *extra* for the future. In spite of the growing demands for the important basic material it produces—Sulphur . . . the company's policy has been to keep on hand stocks equal to about a year's normal demand. With such a supply, it can make shipments, routine or emergency, of any tonnage, at any time, by any method.

Texas Gulf Sulphur Co.

75 East 45th Street, New York 17, N. Y.
811 Rusk Avenue, Houston 2, Texas

Sulphur Producing Units

Newgulf, Texas
Moss Bluff, Texas
Spindletop, Texas
Worland, Wyoming



New—Goulds Fig. 3604—a ¾" pump for chemical circulating and transfer service.

Here's a small pump with big-pump stamina

Ideally suited for handling corrosive materials

Small, compact—this new pump fits in where space is a problem. But you can rely on it for continuous service round the clock, round the calendar.

It's available from stock in 316 Stainless Steel—which provides the widest and most economical coverage of liquids commonly handled by a pump of this type.

The mechanical seal—with carbon, Teflon, stainless steel and ceramic parts—is noncorrosive.

The impeller clearance is externally adjustable to compensate for wear.

The pump is small enough (10½ x 5½ x 5½) and light enough (23 lbs. with motor) for lab or pilot plant operations. It's designed for temperatures to 220° F. and working pressures to 75 p.s.i. Capacities to 16 GPM and heads to 28 ft.

For circulating duty, as a component in larger equipment, this new Goulds chemical pump offers advantages in size, weight, cost, and dependable performance.

Complete information on this high-quality pump—performance curves and specifications—is offered in Bulletin 624A4. You can get a copy from your Goulds representative, or by writing us.

GOULDS

PUMPS FOR CORROSIVES

GOULDS PUMPS, INC.
SENECA FALLS, NEW YORK
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A hot steel circle ready for Claymont's 3000-ton head press. This precision machine is capable of hot or cold pressing heads up to 10 feet in diameter in a wide variety of metals. Integrated facilities make Claymont a reliable source of quality steel plate and plate products for industry.

by d'Arazien

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CHECK CLAYMONT FOR—Alloy Steel Plates • Carbon Steel Plates • Stainless-Clad Steel Plates High Strength Low Alloy Steel Plates • CF&I Lectro-Clad Nickel Plated Steel Plates • Pressed and Spun Steel Heads • Manhole Fittings and Covers • Fabricated Steel Products Large Diameter Welded Steel Pipe

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positive action against air pollution

Positive action, resulting from an aggressive, industry-wide air pollution policy is rapidly replacing the outmoded philosophy—"wait until someone complains . . . or sues." Today good community relations can be as vital and profitable as increased production efficiency.

Dracco Dust Control Equipment—performance-proved in countless applications—is one of industry's most effective allies in this fight against air pollution. Dracco filtration methods assure 99½-100% air cleaning by trapping dust at its source to prevent both internal and external atmosphere contamination.

The National Supply Company solved an air pollution problem and met the stringent requirements of smog-conscious Los Angeles County. The company installed a special Dracco Dust Control system to prevent escape of waste oxides from its electric furnaces.

If your dust problem involves air pollution, recovery of valuable dust or elimination of nuisance dust, Dracco can help you take the positive action needed to solve it. For information call or write Dracco today.

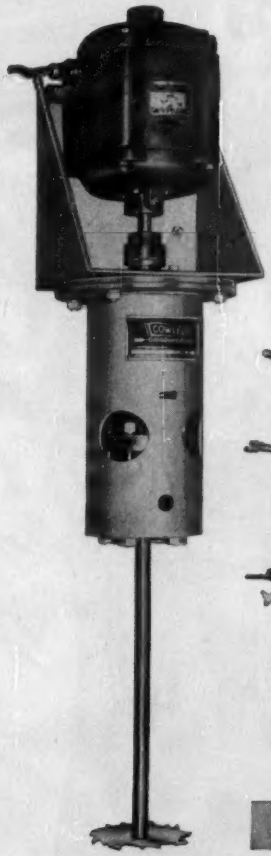
DRACCO DIVISION OF FULLER CO.
4040 East 116th Street • Cleveland 5, Ohio

This Dracco filter unit handles 75,000 cfm of dust-laden air from electric furnaces at National Supply's plant in Torrance, California. Special features of the unit include central classifier-hopper, Dynel filter bags, and automatic discharge of collected dust.

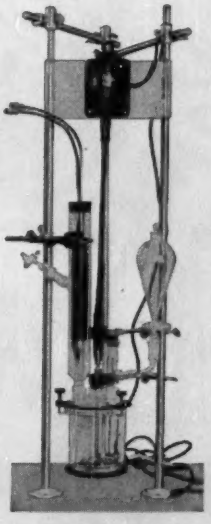
Complete 40-page catalog on Dracco Dust Control Equipment contains detailed data and valuable reference material. Write for Bulletin 800.

DRACCO *airstream* conveyors
dust control equipment

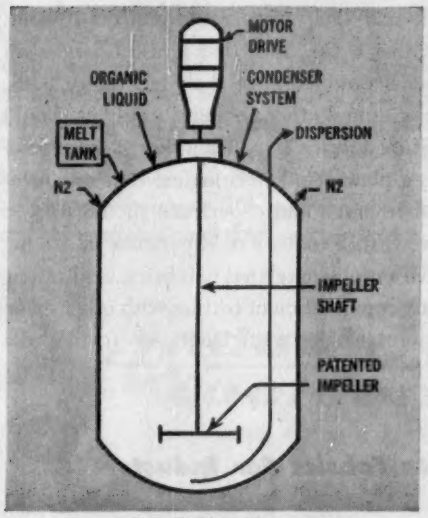
FOR EXOTIC FUELS...



Cowles Pilot-Plant Sodium Dispersion Dissolver



Cowles Laboratory Sodium Dispersion Dissolver



Schematic Plant Diagram

Metallic dispersions finished in 30 minutes or less, particle size as small as two microns, with Cowles Dissolvers.

Largest Manufacturers have selected Cowles equipment

Highest quality metallic dispersions can now be easily controlled and produced in big volume, making many reactions commercially practical for the first time.

Key to the new method is the unique action of the patented Cowles impeller. With rim speeds of up to 6150 fpm, the impeller vanes create a zone of intense turbulence and hydraulic shear. The liquid is moved rapidly through itself until maximum dispersion is obtained. The Cowles thus gives several many very important advantages:

Versatility — prepares material for many reactions under conditions not heretofore possible.

Finer particle size — gives maximum reaction surface to dispersed elements.

More complete dispersion — assures complete homogeneity of material.

Greater speed — cuts finished dispersion time substantially.

Cleanliness — self-cleaning impeller will not clog with metal.

Safety — gives the close control necessary with highly active materials.

Predictable results — laboratory and pilot-plant models provide results easily duplicated in larger models.

New Cowles Dissolvers with properly sealed and specially designed drives for metallic dispersions are available for all purposes. Included are "package" models in both laboratory and pilot plant types, and models for commercial production. All are thoroughly proven in actual plant operations and represent the broad experience and know-how of our organization – the established leader in its field. Specialized engineering assistance can be supplied if desired.

For complete information write today for Technical Bulletin No. 21-1957, "Metallic Dispersions with the Cowles Dissolver."

Additional Cowles Dissolver models are available for efficient processing of all solid-liquid, liquid-liquid and gas-liquid products.

Take advantage of the unusual *Morehouse-Cowles Processing Equipment Application Service* at no obligation – for a comprehensive survey of your plant requirements and end products, with laboratory assistance and in-plant tests at our risk.

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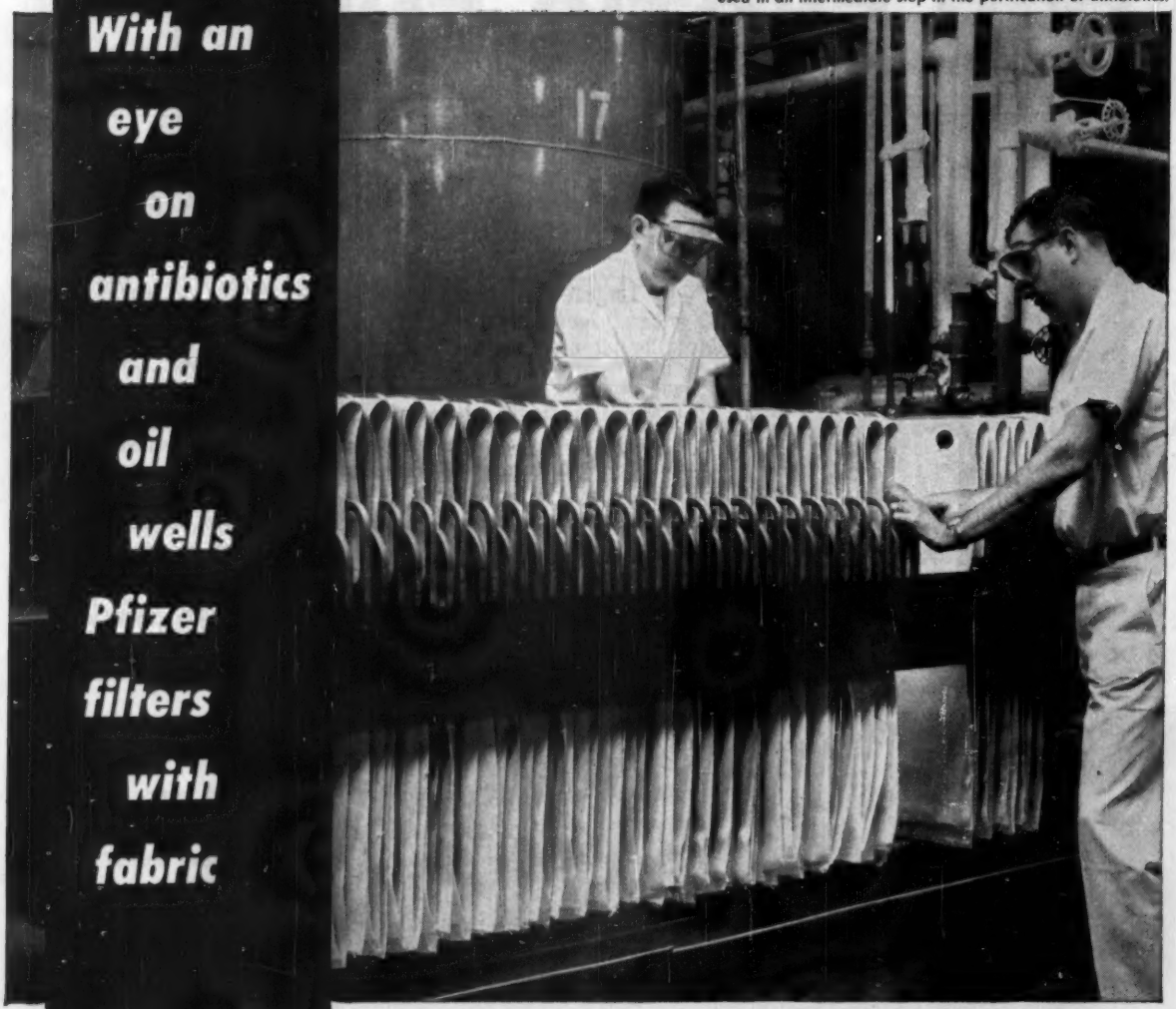
With an eye on antibiotics and oil wells Pfizer filters with fabric

30" stainless steel plate and frame filter press used in an intermediate step in the purification of antibiotics.



A filter cloth being fabricated at Pfizer's Brooklyn "tailor shop." Wellington Sears filter fabrics are used on stainless steel plate-and-frame presses, as shown in large picture, and also on rotary filters.

Through a fabric in a filter pass antibiotics, pharmaceuticals and chemicals which may one day help save a life. Or fight the afflictions of old age. Or control a plant disease. Or—in the case of citric acid—help recover oil from "tired" wells. In the hands of specialists at Chas. Pfizer & Co., Inc., that fabric becomes an active tool in the highly successful mass production of their laboratory finds.

That a leading producer of antibiotics and other chemical products should assign the filter job to Wellington Sears fabrics is still another sign of how importantly fabric figures in industry's plans. And it is logical that organizations with first-hand understanding of research and experience should turn to Wellington Sears, to make use of more than a century of experience in serving the textile needs of industry. If you have a problem related to fabrics, in filtration, rubberizing, coating, laminating, or any combination of textiles with other materials, we'll be glad to help. And for a useful booklet, write Dept. L-7 for "Fabrics Plus," or "Filter Fabric Facts."

Wellington Sears *FIRST In Fabrics For Industry*

WEST POINT MANUFACTURING CO.

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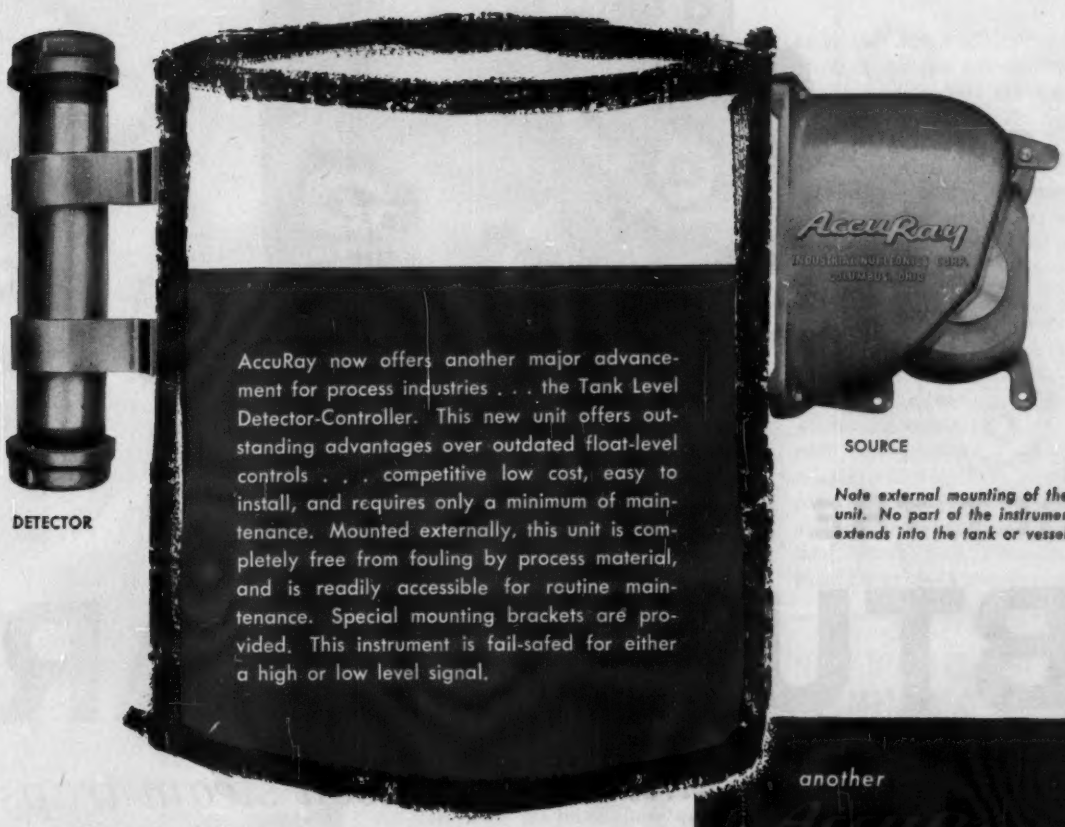
AccuRay TANK LEVEL DETECTOR-CONTROLLER



DETECTOR

SOURCE

Note external mounting of the unit. No part of the instrument extends into the tank or vessel.

AccuRay now offers another major advancement for process industries . . . the Tank Level Detector-Controller. This new unit offers outstanding advantages over outdated float-level controls . . . competitive low cost, easy to install, and requires only a minimum of maintenance. Mounted externally, this unit is completely free from fouling by process material, and is readily accessible for routine maintenance. Special mounting brackets are provided. This instrument is fail-safed for either a high or low level signal.

another AccuRay® advancement for process control

The AccuRay Tank Level Detector-Controller can be used in two ways. It can be installed horizontally to provide a relay closure signal when the level rises above or falls below the level of the detector; or it can be installed vertically so that both a high level and a low level signal can be provided from one instrument. Accuracies can be maintained to plus or minus 1/16". The radiation source is installed either opposite the detector on the tank, or across a chord of the tank. The design of the source housing provides more than adequate shielding. Design of the instrument is in accordance with accepted standards for both explosion-proof and weatherproof operation.

®AccuRay is a Registered Trademark of Industrial Nucleonics Corporation

Please send complete details on AccuRay Tank Level Detector-Controllers.

Name _____ **Title** _____

Company _____

Street _____

City _____ **Zone** _____ **State** _____

Application _____

_____

Industrial Nucleonics
CORPORATION
1149 Chesapeake Ave., Columbus 12, Ohio

The WORLD'S LARGEST Manufacturer of Nucleonic Industrial Process Control Systems

ACTUAL SIZE

GET THE MOST FOR YOUR

BTU DOLLAR

...with Nicholson steam traps

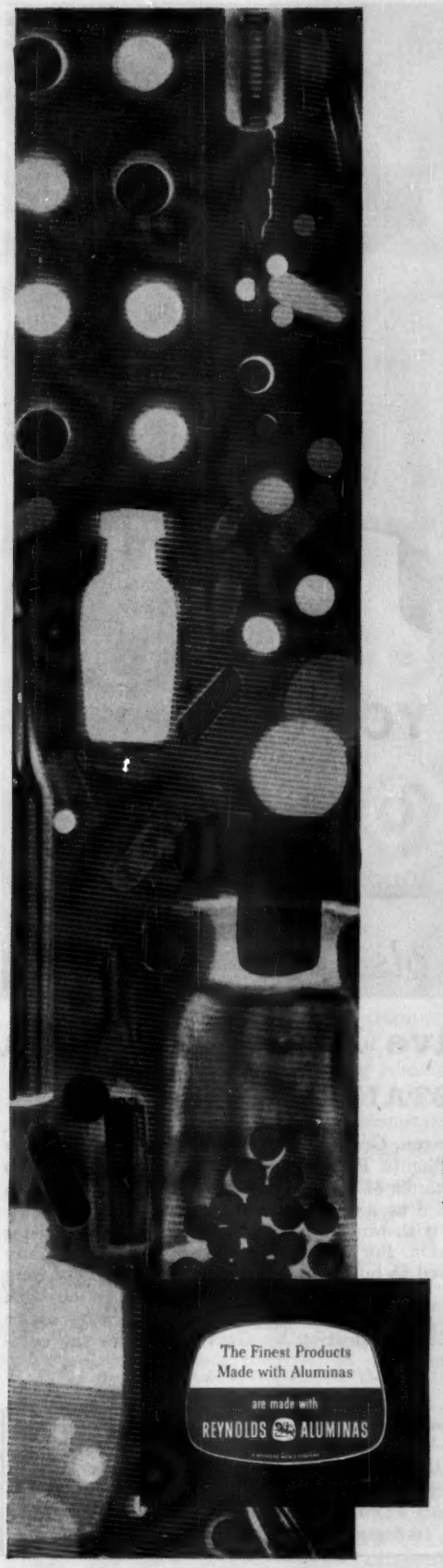
You get top operating temperature per dollar of fuel consumption . . . when you use the Nicholson steam trap. This trap purges all air and non-condensibles from pipes and equipment *continuously* . . . not just at warm-up time. Your boiler doesn't have to operate at top capacity —all the time—to obtain top steam temperature where and when you need it.

Make full use of your BTU dollar, with Nicholson traps. They have only one moving part . . . a valve that operates on just a few degrees of temperature differential.

In your steam generation, and in your steam utilization . . . Nicholson traps will save you money. You can try one . . . without obligation! W. H. Nicholson and Company, 12 Oregon St., Wilkes-Barre, Pa. Sales and Engineering Offices in 98 principal cities.

NICHOLSON

of Wilkes-Barre



The properties to look for in HYDRATED ALUMINAS

Not all $Al_2O_3 \cdot 3H_2O$ is the same. Some batches of hydrated alumina will yield disappointing results in final products, and problems in processing. For this reason, you'll be wise to check for certain properties in your hydrated aluminas:

First, hydrated aluminas should have low organic contamination. Snow-white Reynolds hydrates, produced by a combination Bayer-Sinter process, have virtually no organic content—and won't "yellow" a product. This processing also prevents foaming during reaction, and lowers the alkali content of the hydrates.

Reynolds hydrated aluminas don't have the black specks and streaks that some Bayer-type hydrates have, and their iron content is extremely low.

High Solubility, Purity

You should also be sure that your hydrated aluminas have a high reactivity rate, leaving only trace quantities of insolubles when treated with acids or bases. Reynolds hydrates, R-5002 and R-5003, do have these qualities. They are highly soluble, and about as pure as modern processing methods can make them.

In addition to their high solubility, purity and fast reactivity, Reynolds hydrated aluminas offer a wide range of particle sizes. Two basic types are offered: R-5002, which is specially refined for an extremely low Fe_2O_3 content, and R-5003, for use where the Fe_2O_3 limitations are not as rigid.

Hydrated Alumina Uses

Hydrated alumina is widely used in the production of petroleum cracking catalysts, as an adsorption agent in ceramics and roofing granules, and in sagger washes and mold coatings.

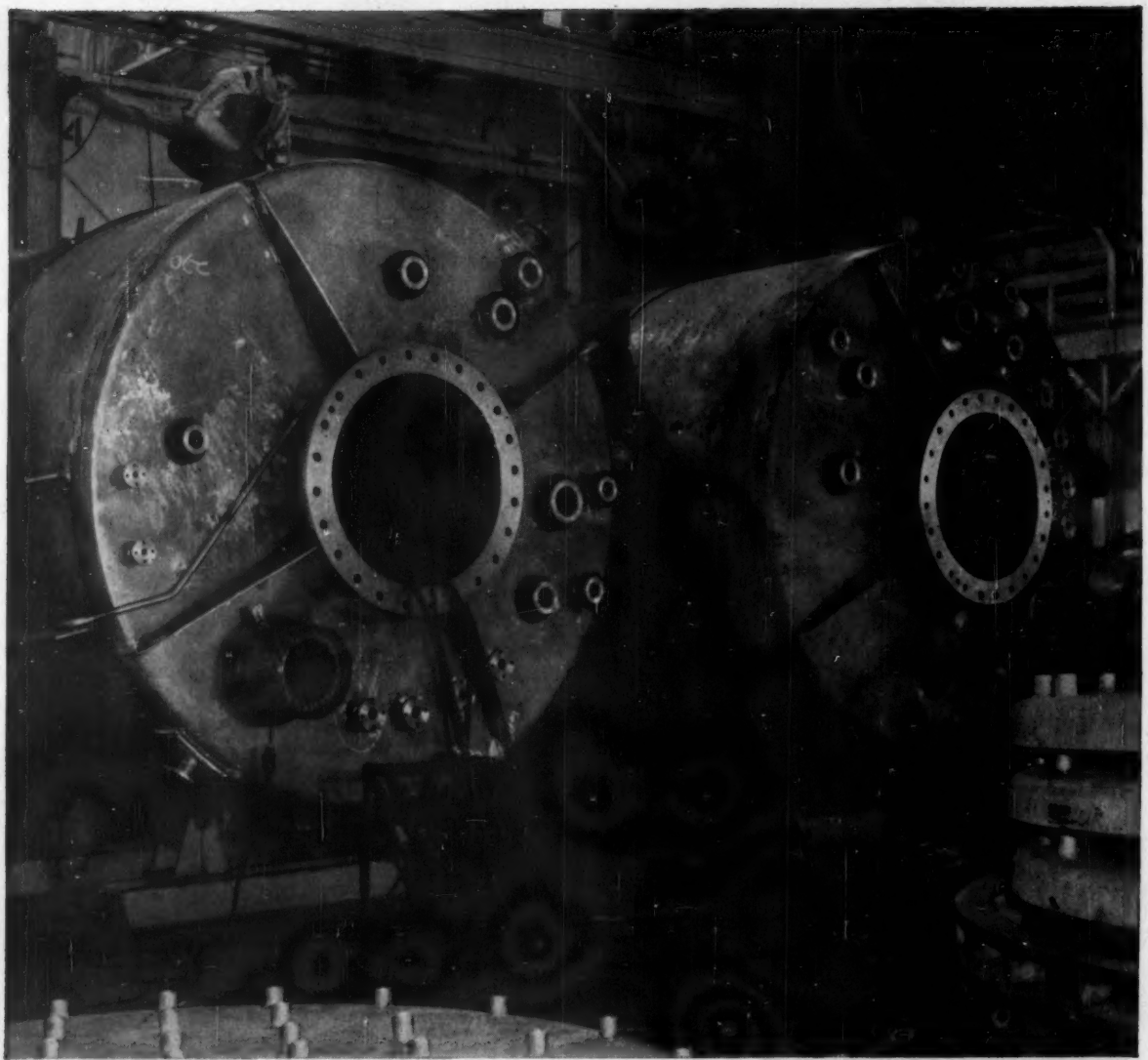
Since it reacts readily with strong mineral acids and alkalies, hydrated alumina is used in production of salts such as iron-free aluminum sulfate, sodium aluminate, basic aluminum sulfate, aluminum chloride and aluminum phosphate. It is used to make glass and ceramics more resistant to heat, shock, and chemicals, and to add sparkle to glass and glazes.

NEW BOOKLET ON ALUMINUM CHEMICALS

Write today for free attractive booklet giving detailed information on the advantages, economies and applications of Reynolds Hydrated Aluminas, Calcined and Activated Aluminas. Write Reynolds Metals Company, P.O. Box 2346-CJ, Richmond 18, Virginia; International Division, 19 East 47th Street, New York 17, N. Y.

REYNOLDS ALUMINUM

Watch Reynolds All-Family Television Program, "DISNEYLAND", ABC-TV.



For Transferring Radioactive Process Wastes,

... DESIGNED IN STAINLESS

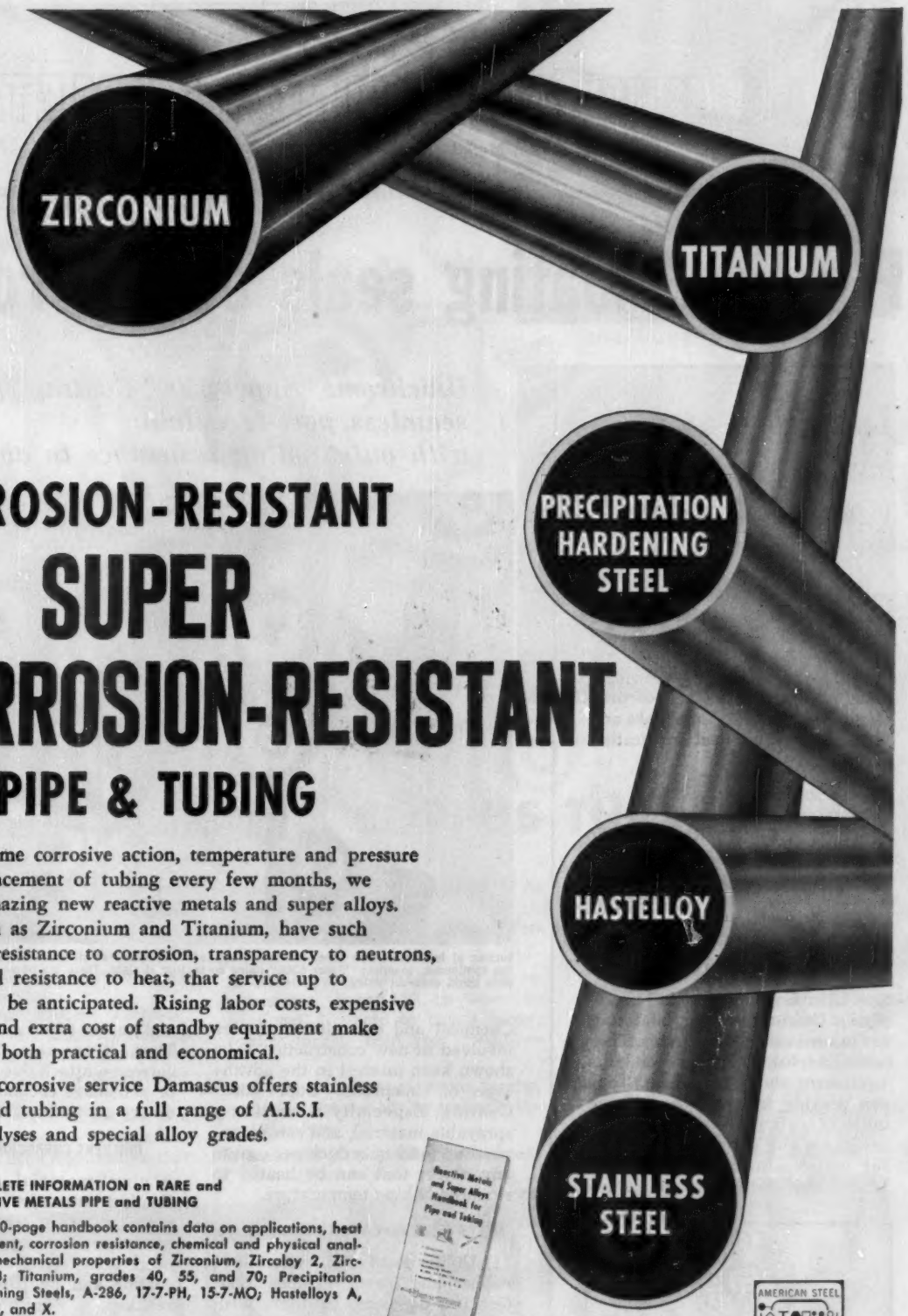
Ever since work on atomic reactors began, Graver has been building stainless tanks for transferring radioactive process effluents. Filled by remote control and cooled to remove heat from radioactive decay, tanks of the design shown above have been in service long enough to now be regarded as a standard for this use.

Stainless is useful for its ability to withstand either basic or acidic liquid wastes for a long time without serious corrosion. For mixed radioactive wastes with many "half-lives", such tanks may be required to hold dangerous isotopes for a very long time. The craftsmanship must be of the highest, which is never a question with Graver's hundred-year reputation for quality fabrication. For atomic energy use or for industrial wastes, stainless and alloy fabrication by Graver provides the complete answer for long-lived installations.

GRAVER®
ALLOY DIVISION

Building for the Future on a Century of Craftsmanship in Steels and Alloys

GRAVER TANK & MFG. CO., INC.
EAST CHICAGO, INDIANA • New York • Philadelphia
Edge Moor, Delaware • Pittsburgh • Atlanta • Detroit • Chicago
Tulsa • Sand Springs, Oklahoma • Houston • New Orleans
Los Angeles • Fontana, California • San Francisco



CORROSION-RESISTANT and SUPER CORROSION-RESISTANT PIPE & TUBING

Where extreme corrosive action, temperature and pressure require replacement of tubing every few months, we offer the amazing new reactive metals and super alloys. Several, such as Zirconium and Titanium, have such remarkable resistance to corrosion, transparency to neutrons, strength, and resistance to heat, that service up to 20 years can be anticipated. Rising labor costs, expensive down-time and extra cost of standby equipment make these metals both practical and economical.

For general corrosive service Damascus offers stainless steel pipe and tubing in a full range of A.I.S.I. standard analyses and special alloy grades.

COMPLETE INFORMATION on RARE and REACTIVE METALS PIPE and TUBING

New 40-page handbook contains data on applications, heat treatment, corrosion resistance, chemical and physical analysis, mechanical properties of Zirconium, Zircaloy 2, Zircaloy 3; Titanium, grades 40, 55, and 70; Precipitation Hardening Steels, A-286, 17-7-PH, 15-7-MO; Hastelloys A, B, C, F, and X.

DAMASCUS TUBE COMPANY

STAINLESS STEEL TUBING AND PIPE

GREENVILLE, PENNSYLVANIA

AMERICAN STEEL WAREHOUSE ASS'N

FORMED STEEL TUBE INSTITUTE

UNICHROME
Trade Mark

News about
COATINGS for METALS
Metallic.....Organic.....Decorative.....Protective

Plastisol coating seals out corrosion

Tank lining has built-in visual cure control

One of a group of Unichrome drum and tank lining materials, Coating B-124 is an unusual phenolic type material. When wet, it is gray in color. When fully cured, it is olive drab. This color change gives visual security against "half-baked" protection especially in large tanks and tank cars where heat application may be uneven.

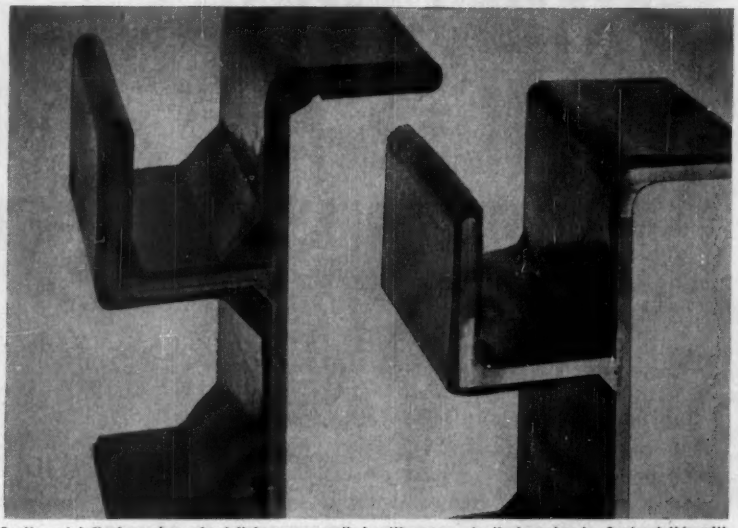
Also in this coating group will be found several pigmented coatings which yield 2-mil thicknesses per coat. That's double the build-up of ordinary phenolic coatings. Obviously, fewer coats are needed, cutting time and costs.

APPLICATOR SERVICE

Specialist firms experienced in applying Unichrome lining materials are located across the country. They are well set up to handle even large equipment shipped to them. They can provide fast service, and the uniform coating with greater impact resistance and improved protection for which Unichrome Phenolic Linings are noted. Send for names.

METAL & THERMIT
CORPORATION
General Offices: Rahway, New Jersey
Pittsburgh • Atlanta • Detroit
East Chicago • Los Angeles
In Canada: Metal & Thermit—United Chromium of Canada, Limited, Rexdale, Ont.

Unichrome "Super 5300" Coating sprays seamless, pore-free lining with outstanding resistance to abrasion



Section at left shows how sheet linings are applied, with seams at all sharp bends. Contrast this with the continuous, seamless "Super 5300" lining on section at right. There are no weak spots where solutions could undercut lining.

Chemical and corrosion engineers involved in new construction have shown keen interest in the advantages of Unichrome "Super 5300" Coating. Especially since it is a sprayable material, and can be applied up to 60 mils thick per coat to any object that can be heated to required baking temperature.

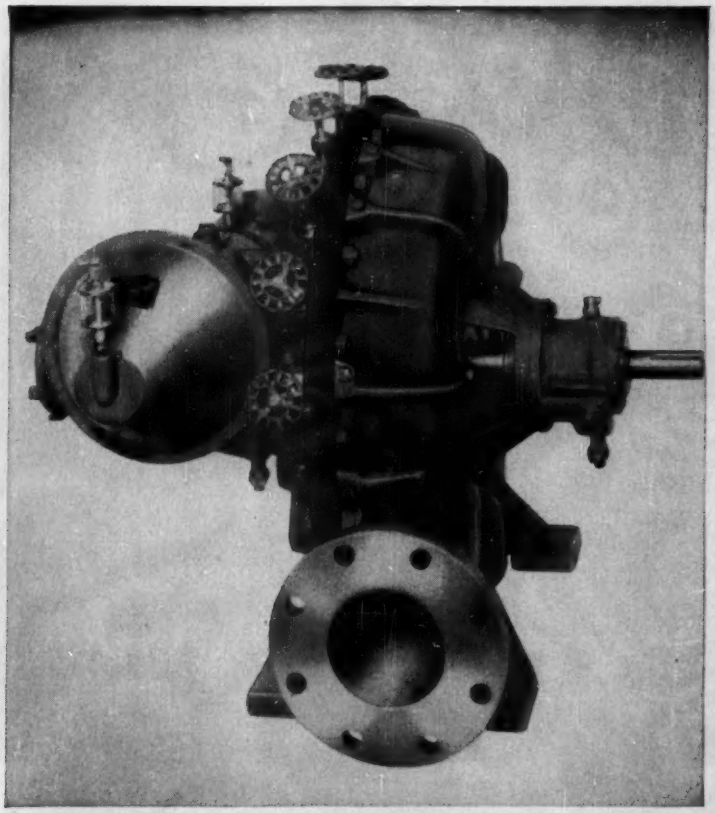
MEETS THREE IMPORTANT REQUIREMENTS

(1) Unlike usual sheet materials of rubber and plastic, "Super 5300" Coating poses no problem with seams. Since it is a liquid material, it forms a continuous coating without air pockets, eliminating potential sources of trouble, even on complicated shapes. (2) Thick and pore-free, it presents no paths for corrosive chemicals to travel to base metal. (3) It withstands abrasion and impact to a remarkable degree. Thus, it securely "seals" against corrosive attack due to penetration or to damage encountered with ordinary protective coatings.

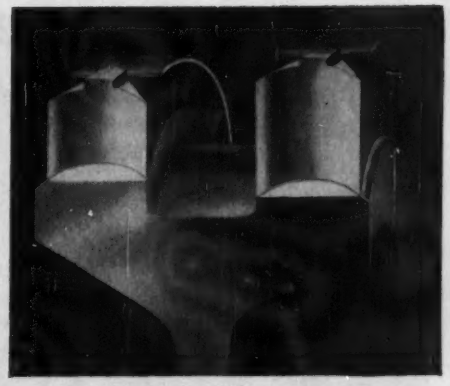
INHERENT CORROSION RESISTANCE

A vinyl material, "Super 5300" Coating naturally resists a broad range of acids, alkalies, moisture and other active agents. Should the need arise, equipment with this coating can be patched and spot rebaked, to reform an impervious "armor" good as new.

"Super 5300" can be applied in-plant; or by expert applicators in key locations who can promptly and proficiently coat the equipment you ship them. Write Metal & Thermit for names. Or for Bulletin Chem-C-3.



This is the reliable Coppus Turbine furnished with either type of wheel



Wide bucket "L" type wheel

Regular type wheel

Top performance in all COPPUS TURBINES

Both the regular type wheel or wide bucket "L" type wheel give you Coppus proven high quality and low maintenance cost. The "L" type wheel is the new development for use where low water rate is essential.

Coppus "Blue Ribbon Turbines" earned their fine reputation right on the job. Users vouch for their top quality performance and their low maintenance cost.

In the words of the supervisor of a large chemical company: "Coppus turbines require so little maintenance that a person would starve to death, if he depended on it for a living."

Proven features of *all* Coppus Turbines:

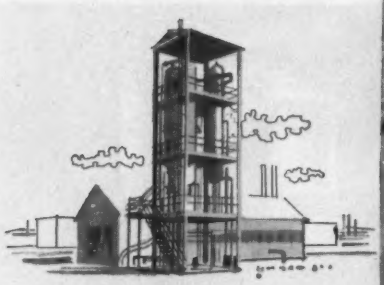
- Turbines rated close to your hp requirements, from 150 hp down to fractional. No need to buy a bigger, costlier turbine than your conditions call for.
- A larger number of steam nozzles, controlled individually by manually operated valves.
- Exclusive pilot operated excess speed safety trip supplementing constant speed governor.
- Replaceable cartridge type bearing housings.
- Optional carbon ring packing glands.

Coppus Steam Turbines ranging from 150 hp down to fractional, in 6 frame sizes, ***make turbine dollars go farther.*** Send for Bulletin 135 on Coppus Turbines.

COPPUS ENGINEERING CORPORATION
228 Park Avenue, Worcester 2, Mass.
Sales offices in THOMAS' REGISTER

COPPUS "BLUE RIBBON" TURBINES

Pilot plant reactor shell *after 2000 hours service. Note corrosion on stainless steel shell and flange, while titanium liner shows no corrosion effects. Right: Titanium dip-tube after 2000 hours operation remains free of corrosion damage.*



In high-temperature nitric acid service...

TITANIUM WINS TOUGH 2000-HOUR CORROSION TEST

A large petrochemical company recently tested titanium versus other metals in high-temperature nitric acid service. 6% to 10% concentrations were handled in a pilot plant reactor at temperatures between 300° to 400°F.

Above you see dramatic proof of titanium's performance in this punishing service. After 2000 hours, the reactor's titanium liner and dip-tube showed no corrosion effects, while the stainless steel shell and flanges were badly corroded.

Further corrosion-rate tests were made by immersing test coupons of various metals in the reactor for 40 hours. Again, test results proved titanium's outstanding corrosion resistance (see chart at right).

Want more information? Write for bulletin on Corrosion Resistant Properties of Titanium.

CORROSION RATE TEST
Conditions: 375° F, 300 psig, 6% nitric acid

Material	Corrosion Rate mils/yr
Titanium	nil
347 stainless steel	59
304 stainless steel	170
310 stainless steel	274
410 stainless steel	402
309 stainless steel	485
Nickel-Chrome Alloy	20,500

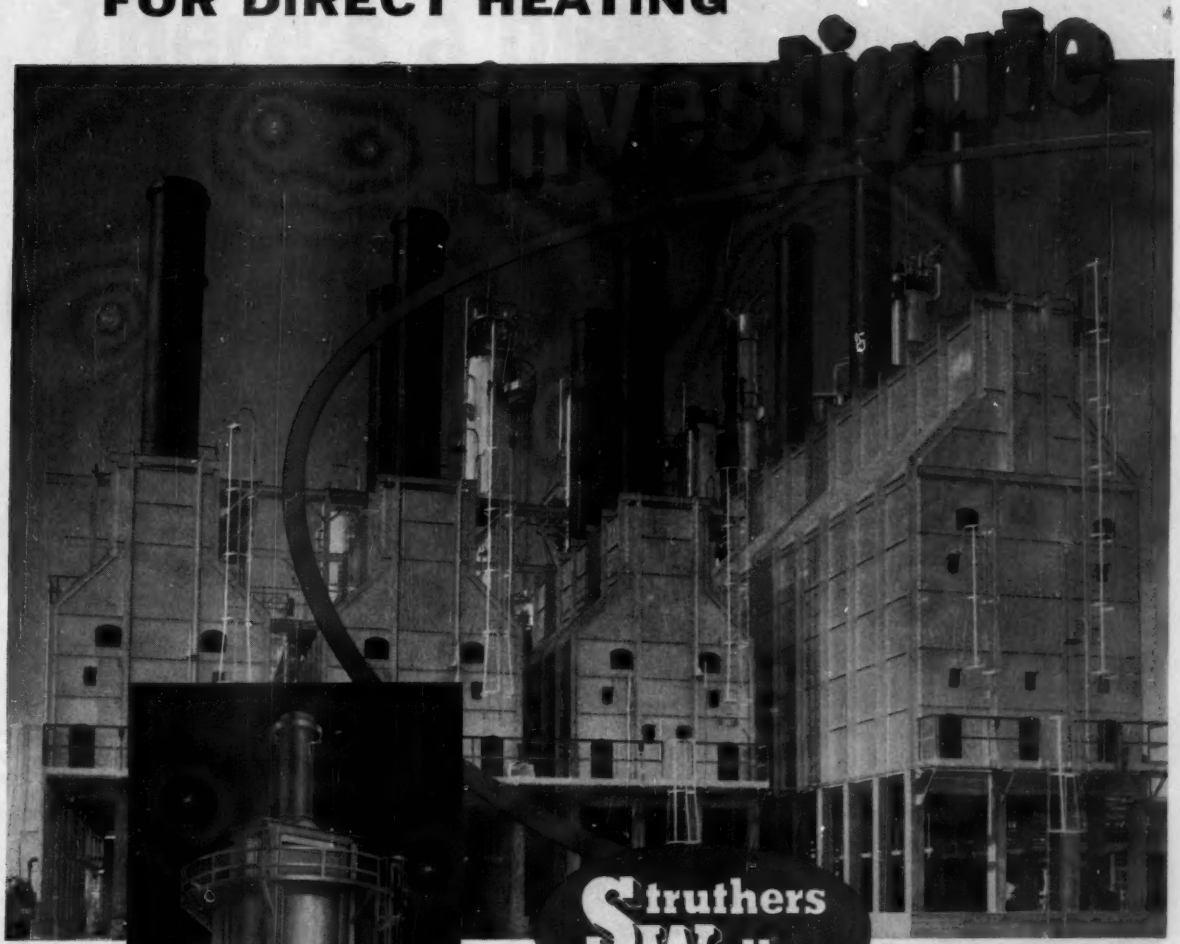
See our 4-page ad in Chemical Engineering Catalog, Pages 1147-1150, for additional technical information.

MALLORY SHARON

MALLORY-SHARON METALS CORPORATION • NILES, OHIO

Integrated producer of Titanium • Zirconium • Special Metals

FOR DIRECT HEATING



Struthers Wells

FIRED HEATERS

- Long, trouble-free Service
- High Thermal Efficiency
- Highest Temperatures and Pressures

For direct heating of liquids and vapors to temperatures about 1750°F, in any commercial pressure range, Struthers Wells can supply a wide variety of fired heaters to match your heating requirements.

Many units are being supplied to the petroleum and petrochemical industries, for direct heating of oil and hydro-carbon gases, and for cracking service. Equipment is supplied to heat gases to high temperature for chemical plant service, and for thermal and catalytic cracking of chemical compounds.

Heating units and complete systems have been supplied using circulating mediums, to temperatures above 1700°F.

Special heaters supply high temperature water or superheated steam, at high pressures.

Standard designs allow us to make quick quotations and fast deliveries, for most services.

Write on your letterhead for new Bulletin A-46, describing standard heaters.

STRUTHERS WELLS CORPORATION

WARREN, PENNA.

STRUTHERS WELLS PRODUCTS

PROCESSING EQUIPMENT DIVISION

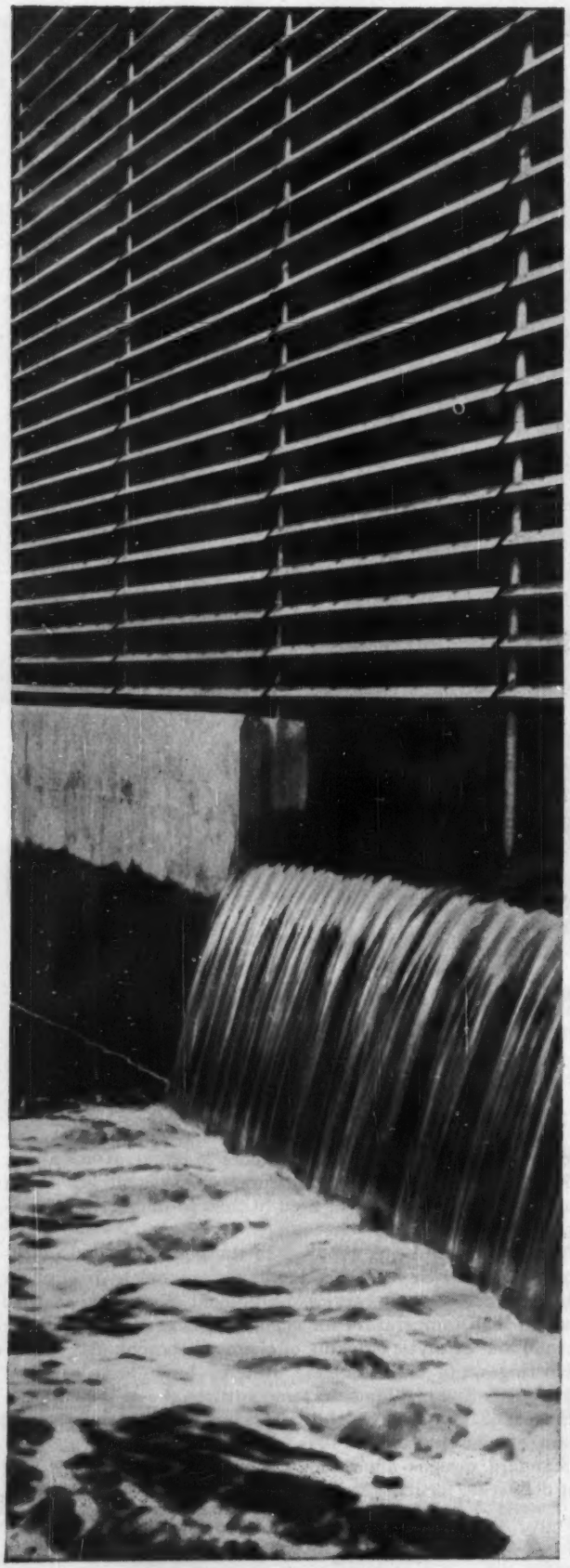
Crystallizers . . . Direct Fired Heaters . . . Evaporators . . . Heat Exchangers . . . Mixing and Blending Units . . . Quick Opening Doors . . . Special Carbon and Alloy Processing Vessels . . . Synthesis Converters

BOILER DIVISION

BOILERS for Power and Heat . . . High and Low Pressure . . . Water Tube . . . Fire Tube . . . Package Units

FORGE DIVISION

Crankshafts . . . Pressure Vessels . . . Hydraulic Cylinders . . . Shafting . . . Straightening and Back-up Rolls



Wanted! 215,000,000,000 gallons of water per day!

Your process cooling towers may be doing a fulltime job now, but soon you'll have to work them overtime. By 1975, report authorities, industry *alone* will require 215,000,000,000 gallons of water per day!

To stand up to such intensive usage, towers should have the protection that only continuous L&N pH control automatically provides. L&N engineers treat each tower as an individual pH problem. Its control system is engineered on the basis of L&N's pH Controllability Analysis. This appraisal of the tower's "controllability factors" (flows, retentions, concentrations, etc.) tells us whether pH is actually controllable under existing tower conditions. If the answer is negative, the analysis highlights what must be done to *make* pH controllable.

The benefits of this unique L&N approach are significant. They include, in the words of an operator of two 200,000-gallon towers, ". . . conserving large amounts of make-up water, wood protection, prevention of carbonate scale, and more effective slime control." His report adds that "automatic pH control at both plants has been effective and satisfactory."

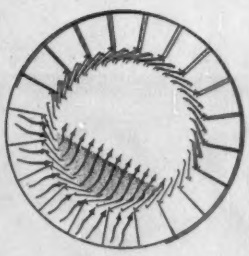
Write for Process Data Sheet 700(1), "L&N pH Control of Cooling Tower Water." You'll also receive our Controllability Analysis Questionnaire to complete and return, without obligation, for answers to your cooling tower pH problems. The address, Leeds & Northrup Co., 4916 Stenton Ave., Phila. 44, Pa.

LEEDS & NORTHRUP
Instruments — Automatic Controls • Furnaces

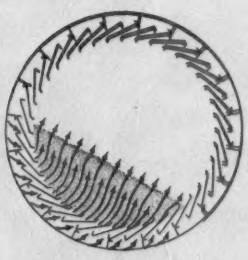
Photo courtesy J. F. Pritchard Co.

There's a big difference in rotary dryers

Link-Belt Roto-Louvre Dryers provide precise processing for heat-sensitive, friable and hygroscopic materials



Section thru feed end

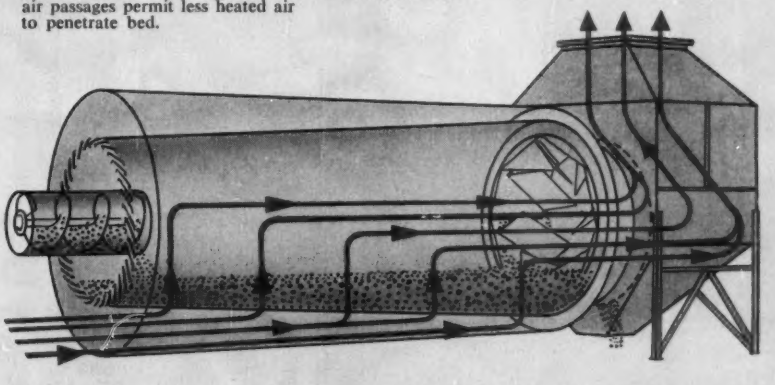


Section thru discharge end

1. NO OVERHEATING — Large volume of hot, dry air easily penetrates thin bed at feed end for maximum heat transfer where greatest evaporation can take place. At discharge end, smaller air passages permit less heated air to penetrate bed.

2. NO BREAKAGE — Material rolls gently over itself in a spiral path to the discharge end of the dryer, minimizing abrasive effects and degradation.

3. UNIFORM DRYING— Each face of every particle is reached many times by hot gases.

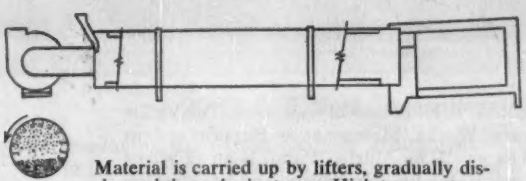


4. LOW MAINTENANCE — Mounted parallel on trunnion rollers, Roto-Louvre maintains its alignment.

5. LONG LIFE — Material rolls over itself—no abrasion of louvres. Hot gases hit metal only 25% of time.

6. COMPACT — Short retention time often saves up to 50% of floor space needed for other dryers.

Single-shell dryer for non-sensitive materials



Material is carried up by lifters, gradually discharged through air stream. High temperatures can be used for high-capacity drying of non-sensitive materials having uniform particle size. Although first cost is low, abrasive action is high as are space requirements.

For facts on the broad Link-Belt dryer line, see your nearby district office. And for data on the Roto-Louvre, write for Book 2511.

Only the Link-Belt Roto-Louvre offers all these advantages

ALTHOUGH Link-Belt builds several types of dryers, including a superior single-shell design, we recommend the Roto-Louvre wherever *sensitive* materials are to be processed. When there's a problem of overheating, breakage, variation of particle size or floor space—this precision dryer is the answer. We'll be glad to laboratory-test a sample of your material—a pound or a ton—work out drying, cooling or roasting procedures you can duplicate in your own plant.

LINK-BELT

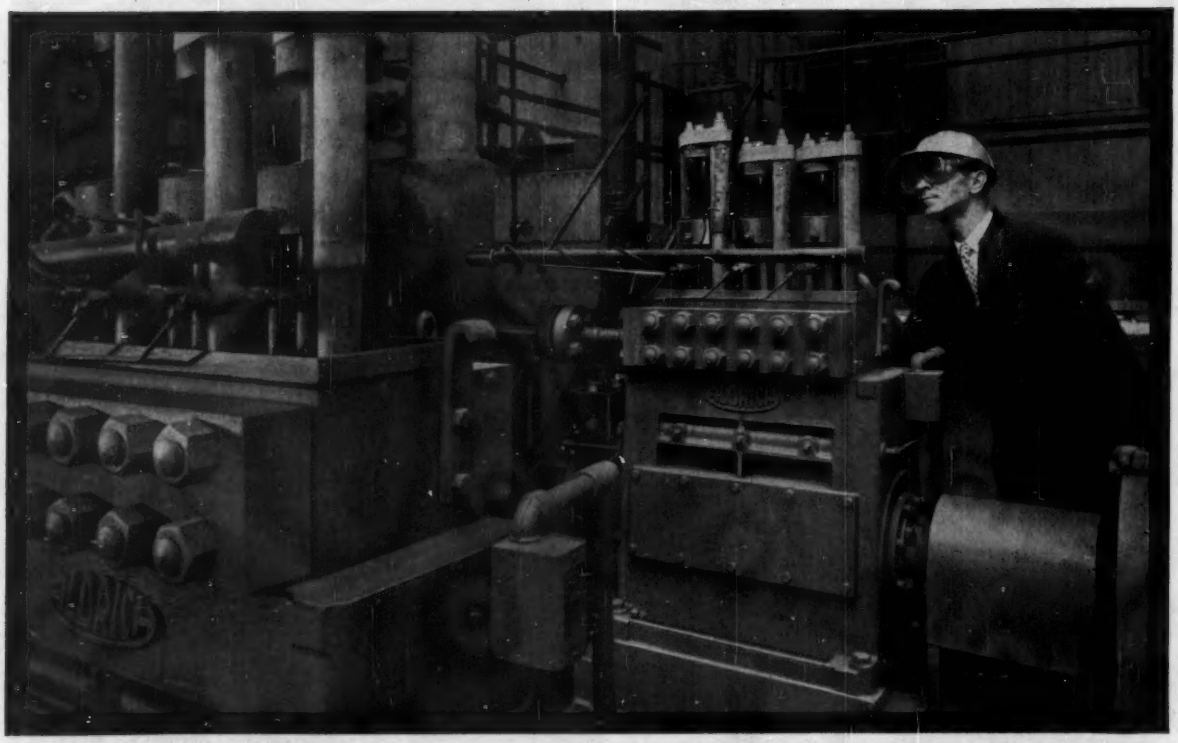
DRYERS • COOLERS • ROASTERS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World. 14,305

SPENCER CHEMICAL CO. UNRAVELS KNOTTY PROBLEM:

Maintaining a controlled flow of liquid ammonia at high pressures, 24 hours a day.

At the Vicksburg, Miss. plant of Spencer Chemical Company, ammonia production demands two things of pumps: (1) 24-hour, 7-day-week operation and (2) continuous flow of controlled volumes of liquid ammonia at high pressure.

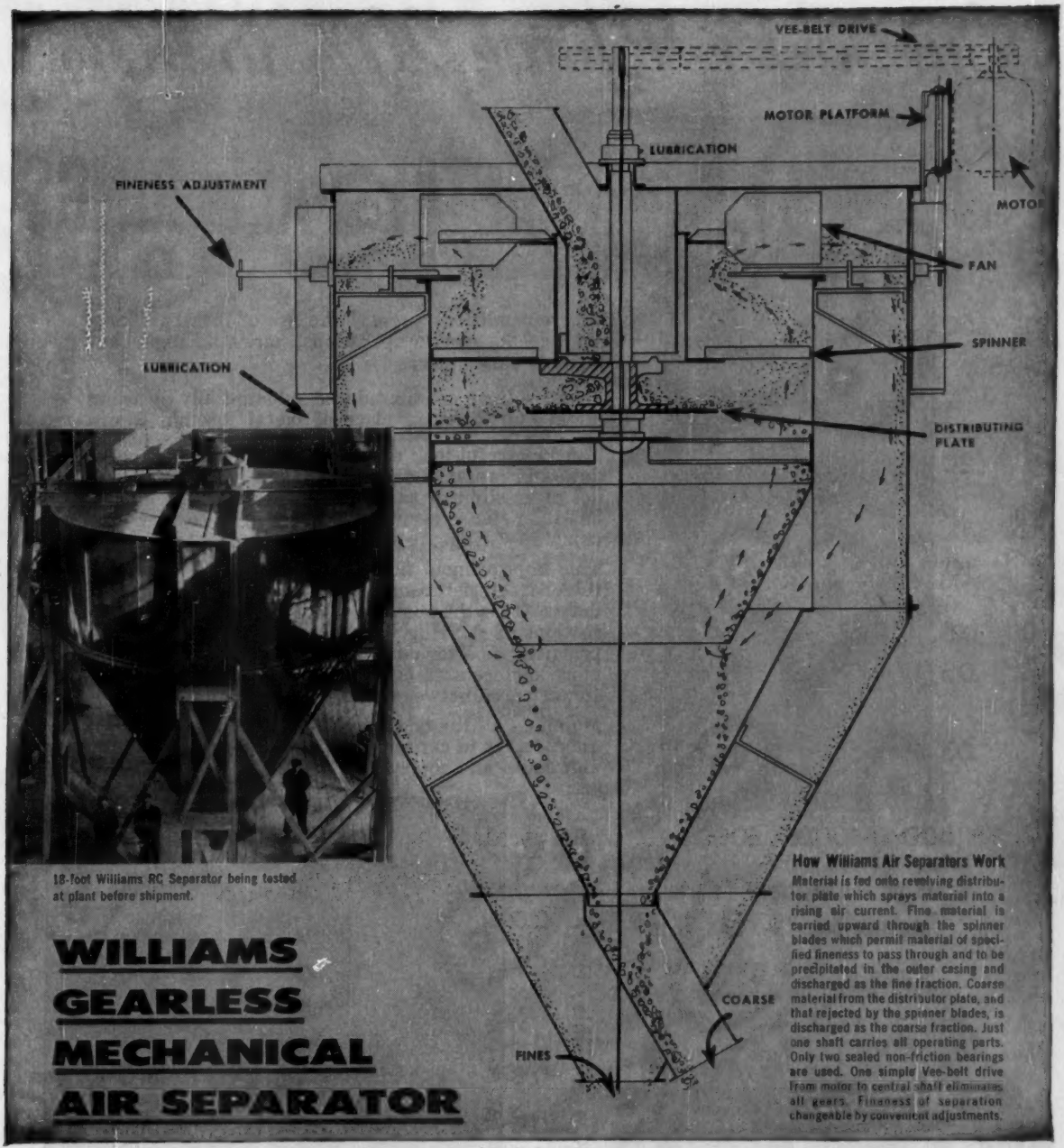


How Spencer licked the problem: When Spencer began outlining construction plans in 1951, company engineers specified two Aldrich Direct Flow, ¾" x 3" stroke Triplex Pumps. These were scheduled to be used for alternate 30-day periods. According to company spokesmen, nearly four years of service have proved these pumps to be efficient and capable of durable service.

Results: Dependability and freedom from trouble in all phases of operation. The Vicksburg Works Maintenance Superintendent tells us: "The Aldrich Pump is an excellent unit. Valve life is excellent and packing life exceptionally good."

We'll be glad to send you full information on Aldrich Pumps and their advantages to you. Simply write Aldrich Pump Company, 3 Gordon Street, Allentown, Pa.

the toughest pumping problems go to ALDRICH



18-foot Williams RC Separator being tested at plant before shipment.

WILLIAMS GEARLESS MECHANICAL AIR SEPARATOR

How Williams Air Separators Work

Material is fed onto revolving distributor plate which sprays material into a rising air current. Fine material is carried upward through the spinner blades which permit material of specified fineness to pass through and to be precipitated in the outer casing and discharged as the fine fraction. Coarse material from the distributor plate, and that rejected by the spinner blades, is discharged as the coarse fraction. Just one shaft carries all operating parts. Only two sealed non-friction bearings are used. One simple Vee-belt drive from motor to central shaft eliminates all gears. Fineness of separation changeable by convenient adjustments.

20 To 325 Mesh Separations—Trouble-Free Gearless Operation

For removing fines from coarsely ground material or for making separations of fine material (the separations ranging from 20 to 325 mesh), Williams Mechanical Air Separators provide the lowest cost, maximum production equipment yet devised. Separation is by specific gravity and no fine delicate screens are employed. Output is unusually high even for fine separations. Construction is heavy duty throughout with heavy steel plate casing, simple gearless drive and heavy internal construction. Only two anti-friction bearings are used. They are enclosed in dust-proof and moisture-proof housings. All sizes permit adjustment for wide variation in fineness of separation. Let us send you complete information.

9 Standard sizes. Capacities, ¼ ton to 75 tons hourly.

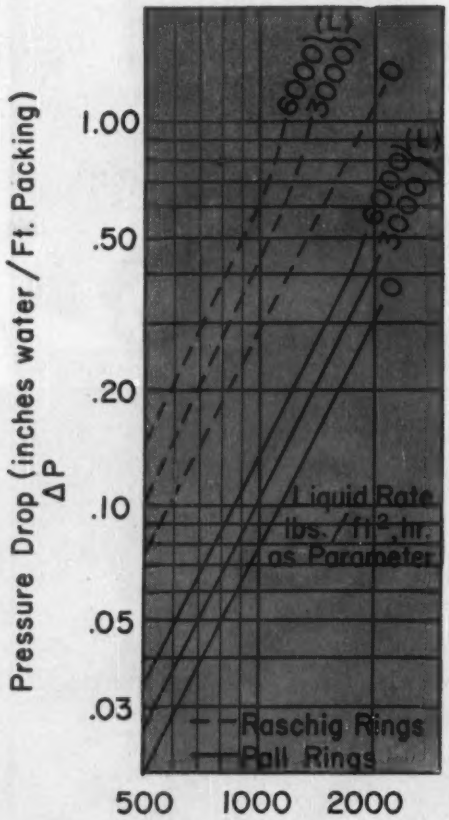
WILLIAMS PATENT CRUSHER & PULVERIZER CO.
2706 North 9th Street **St. Louis 6, Mo.**

WILLIAMS
CRUSHERS GRINDERS SHREDDERS
Oldest and Largest Manufacturers of Hammer Mills in the World

Cut Tower Volume 20% to 40%

with

METAL PALL RINGS



PRESSURE DROP vs. GAS RATE

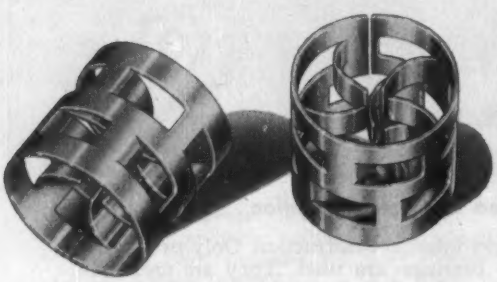
Where conditions suggest the use of metal packing rings in absorption operations, here's an important point to remember:

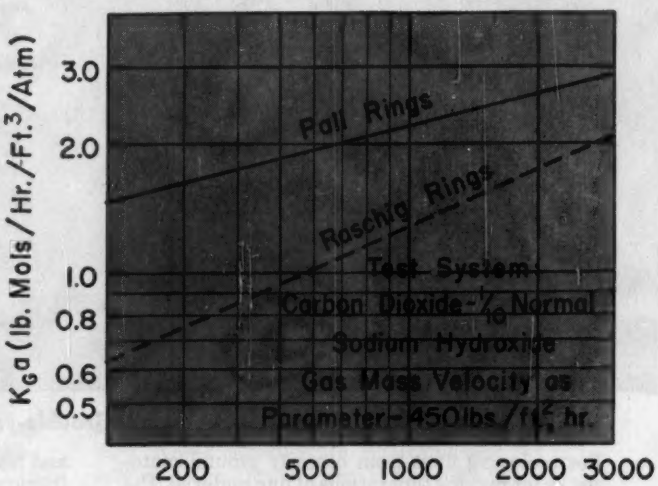
Tower volume can be reduced substantially by using metal Pall Rings in place of metal Raschig Rings.

Take a careful look at the graphs. They show capacity data and pressure drop data taken from tests run not in an eight or twelve inch tower but in our new 30" diameter experimental tower. The tests were made using 1½" rings, packed to a depth of 8 feet.

This improvement in performance results purely from the characteristics of the Pall Ring. The Pall Ring differs from the conventional Raschig Ring in that sections of the ring wall are stamped and bent inward permitting better circulation of liquid and gas. Thus, more surface area is wetted resulting in greater active contact area between phases.

Metallic Pall Rings are made at present in 1", 1½" and 2" sizes in carbon steel, stainless steel, aluminum and copper.





MASS TRANSFER COEFFICIENT vs. LIQUID RATE

For full information —

on Pall Rings and on other tower packings, write for a copy of Bulletin TP-54.

U. S. STONEWARE

AKRON 9, OHIO

101-F

DEVELOPMENTS . . .

JULY 28, 1958

Chementator

C. H. CHILTON

Production of acetic and formic acids from NSSC mill black liquor is now commercial. New unit at Sonoco Products' Hartsville, S. C., paper mill has just gone into operation.

Chicago's Sanitary District reports success with pilot plant for wet oxidation of organic wastes (Zimmerman process). Full-scale unit is strong possibility for near future.

Two new electric furnaces that reciprocate, rather than rotate, are now in operation at Keokuk Electro-Metals Co., Rock Island, Wash. Keokuk has a license from Elektrokemisk, whose basic patent covers any form of relative motion between charge and electrodes in manufacture of calcium carbide and ferroalloys.

Aeration tames sodium sulfite waste

Just now coming on stream at Sherwin-Williams' Chicago plant is a new unit for disposing of sodium sulfite waste by air-oxidation to sodium sulfate.

Waste stream, loaded with sulfite, comes from S-W's para-cresol and beta-naphthol operations (*Chem. Eng.*, Jan. 1953, p. 127). In these processes, caustic fusion of aromatic sulfonic acids yields the desired end products while liberating sodium sulfite.

Chicago's Metropolitan Sanitary District has asked Sherwin-Williams to control the sulfite in its waste stream, since too much sulfite puts a heavy burden on the District's sludge aeration plant. Sulfate, on the other hand, is no problem.

Business end of S-W's new unit is a piece of special equipment made by mixing Equipment Company. This device whips atmospheric air into the sulfite solution with a high degree of dispersion, apparently achieving a level of air oxidation not previously attained on a commercial scale.

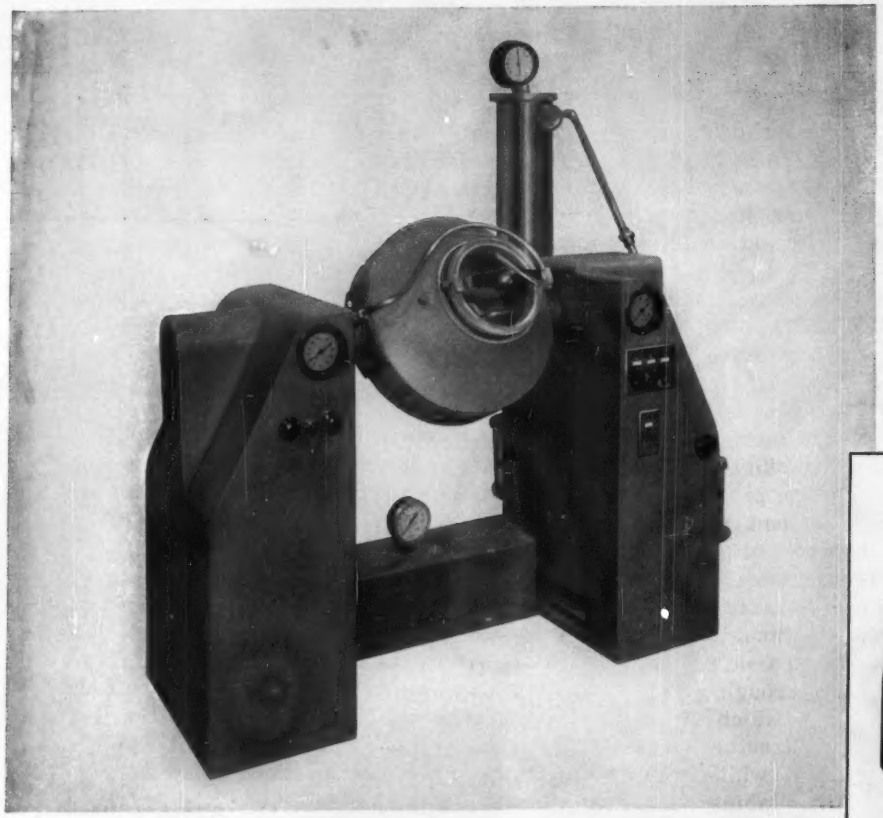
Despite the simplicity of this scheme, it was not Sherwin-Williams' first choice. Original idea—in which the company sunk $500,000 worth of research and development—was to recover liquid sulfur dioxide from the waste sulfite stream. S-W won't reveal details of proposed process, explains that lack of an attractive market for SO_2 was chief reason for scuttling the project.

New cracking catalysts to the fore

Latest development in the field of petroleum cracking catalysts—one likely to set a new trend—is the merger of synthetic and natural materials into single proprietary products.

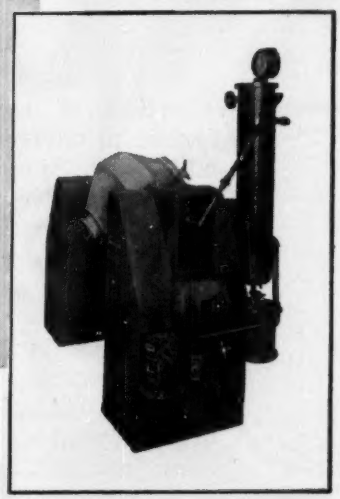
American Cyanamid and National Aluminate have both embraced the if-you-can't-lick-'em-join-'em principle with new catalysts now ready for commercialization. Cyanamid an-

(Continued on page 53)



Completely integrated vacuum drying system using P-K Vacuum Tumbler Dryer Blender.

Side view, showing vacuum pump, condenser and related components. Note compact arrangement and short lengths of piping.



The P-K Vacuum Tumbler Dryer

A faster, better way to vacuum-dry heat sensitive materials

The remarkably fast drying action of the P-K Vacuum Tumbler Dryer—a fraction of the time required by conventional methods—is partly accomplished by baffling in the jacket, which circulates the heating medium uniformly around the containing vessel. In addition, rapid generation of vapors produces a scrubbing action on the walls of the blender, improving the heat transfer rate to a marked degree.

These factors, important as they are, do not tell the whole story. The P-K Dryer operates at optimum efficiency when it is part of a completely integrated, factory engineered system, instead of an on-site assembly of component parts and piping—which increases the cost and impairs the attainable benefits. For heat senstive material drying, in a closed system, there must be a perfect balance of jacket circulation, vapor filter, vapor line, *compact* piping, vacuum line, vacuum pump and effective controls.

These essential relationships P-K provides, including factory designed supports to house the entire operation. The illustrations show a unit used in P-K's Customer Service Laboratory to pre-test the specific requirements of your formulae. You are urged to use this service without cost or obligation. Similar integrated units can be designed for your needs in capacities from 1 to 150 cubic feet.

Use the coupon to secure Data Sheet No. 1530. Better yet, contact our Customer Pre-test Department for a test if your heat sensitive formulations are difficult to produce rapidly, satisfactorily—and economically.

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Chemical and Process Division

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nounced its Aerocat 2000 last month; National has not yet unveiled its new Nalco 783 but admits that sufficient quantities are being made to fill developmental orders. Both firms emphasize that the new catalysts are not yet in full-scale refinery use.

Natural clays (e.g., kaolin, montmorillonite, bentonite, halloysite) and synthetically prepared silica-alumina products can both be used in catalytic cracking, although not necessarily interchangeably. Clays are cheaper, of course, and more stable, but don't usually measure up to synthetics in ability to turn out high-octane gasoline. (One producer of kaolin catalysts claims equivalent performance; see *Chementator,* Nov. 1957, p. 136.)

Chief physical difference between natural and synthetics is that natural clays are crystalline, while synthetics are amorphous. In making Aerocat 2000, however, Cyanamid puts its unidentified high-purity clay through an unidentified chemical treatment which transforms it into an amorphous structure, thus enhancing its catalytic activity while maintaining natural clay's inherent stability.

Cyanamid is pushing its combination natural-synthetic catalyst as a low-cost way to purge cat crackers of heavy-metal contamination which can seriously affect straight synthetics. At $225/ton (vs. $294 for low-alumina synthetic and $330 for high-alumina synthetic), the refiner can afford to bleed off enough catalyst to keep contamination down and activity up.

Turn waste pickle liquor into an asset

Anyone who could dispose of waste sulfuric acid pickle liquor at a profit would—like the proverbial mousetrap inventor—find the steel industry beating a path to his door.

Such a process is that originated by Mellon Institute's Richard D. Hoak (U. S. 2,712,980). Crucible Steel and Rust Engineering have had commercialization under consideration for the past year. Process has been demonstrated at Crucible's Midland, Pa., plant, and patentable improvements have been made by Crucible.

Process involves reaction of sulfuric acid pickle liquor with coke-oven gas and, for that reason, is applicable only where coking and pickling operations are carried out in the same vicinity. But there are many such sites.

The Hoak process uses waste pickle liquor to make ammonium sulfate from the ammonia content of coke-oven gas, thereby reducing the need for fresh concentrated H_2SO_4 now used for this reaction. Other useful products are a high-grade iron oxide, elemental sulfur, ammonium thiocyanate and calcium ferrocyanide. All constituents of the starting materials, including H_2S and HCN, end up as potentially salable products.

Key step is oxidation of iron sulfides (formed from the H_2S in the gas and the iron in the liquor) to produce ferric oxide and free sulfur. This is done by aeration of the slurry (with air or oxygen) under conditions of intense agitation at 45-50 C. and pH 6.5-7.5.

How cheap is Britain's atom power?

U. S. politicians who have publicly and privately lambasted the AEC for letting Britain take the lead in commercial nuclear power with its gas-cooled reactor program may be a bit more charitable in the face of recent frank pronouncements emanating from the U. K.

When Britain started up the world's first commercial-scale nuclear power plant—the Calder Hall station, using a gas-cooled reactor (*Chem. Eng.,* Dec. 1956, pp. 114-6), Sir Christopher Hinton, then of the U. K. Atomic Energy Authority, estimated that power cost would be less than 7 mills/kwh.

Last month Hinton, now chairman of the Central Electricity Generating Board, admitted to an electric power convention that original estimates of nuclear power costs were too optimistic, in part because of overestimating the return from reuse of plutonium.

Hinton now maintains that if substantial cost reductions haven't been achieved by 1965, Britain will have to make a decision between building uneconomic nuclear plants and reverting to conventional power plants. He picks development of better and more-efficient fuel elements as the main cost problem.

Another news item apparently ties in with this picture. It was the announcement in June that British civil nuclear power stations are being modified to produce fissile Pu-239 for military warheads instead of the non-fissile Pu-240 currently scheduled for fuel-enrichment usage.

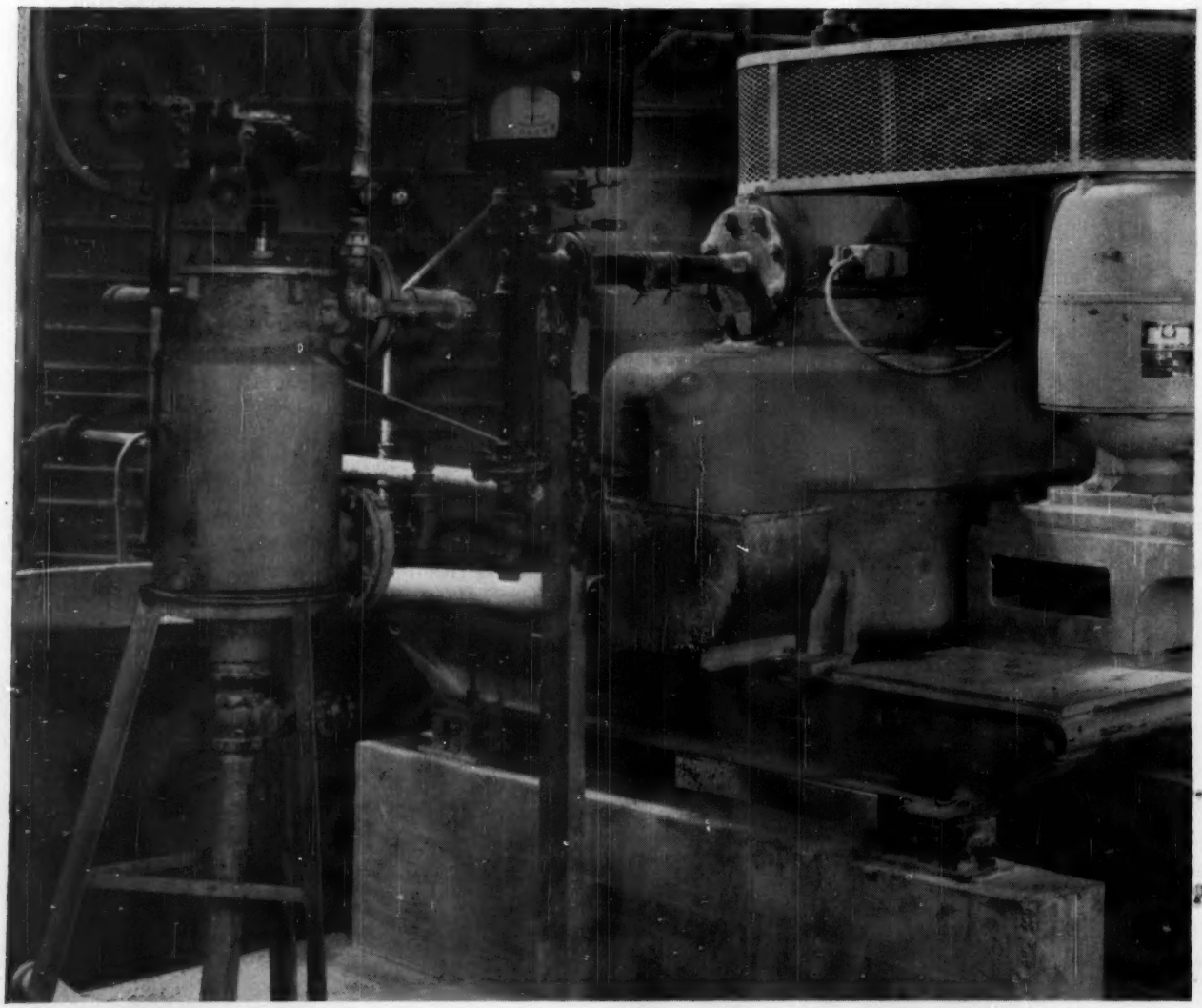
This decision is a surprising reversal of Britain's policy to divorce the military and

(Continued on page 56)

Merco Centrifugal Classification of Micron Size Particles

In the production of extra fine grade bentonite clay . . . a large mid-western chemical company makes skillful use of the effectiveness of Merco Centrifugal Separators in classifying micron size particles.

In this beneficiation process, the clay, after a primary rough cut, is fed to a Merco A-24 Centrifugal Separator for secondary classification.



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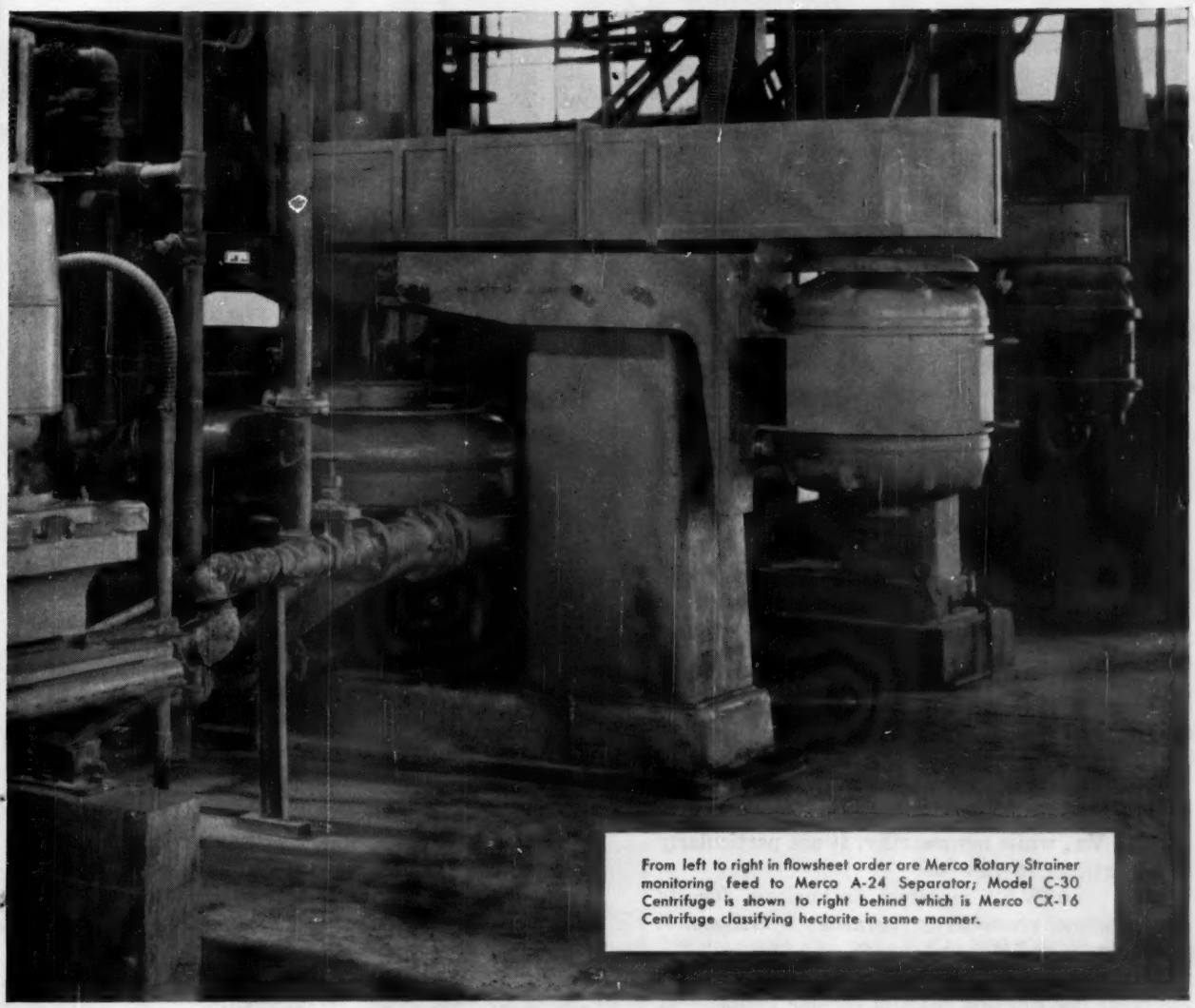

From left to right in flowsheet order are Merco Rotary Strainer monitoring feed to Merco A-24 Separator; Model C-30 Centrifuge is shown to right behind which is Merco CX-16 Centrifuge classifying hectorite in same manner.

civil potentials of its nuclear power program. It means that Britain is giving up its claim to be the only country in the world with a substantial nuclear power program operated solely for civil use.

The new policy not only slashes the cost of military plutonium but is seen in some quarters as a means of providing the new power plants with a more favorable credit for its spent fuel elements.

Kwh. replace costly oxidizing agent

Dept. of Agriculture and Newark College of Engineering are teaming up to develop a low-cost process for making dialdehyde starch, a product with large potential as an adhesive, thickening agent, plasticizer, paper size and chemical intermediate.

Process being investigated is electrolytic oxidation of corn starch. Brought to the 100-lb./week stage in the USDA laboratory at Peoria, Ill., the process will be explored further at Newark in a stepwise program, starting first with a 100-amp. unit and working up to a 2,000-amp. model. Commercial cells may be on the order of 10,000 amp.

Electrolytic oxidation is designed to beat the high cost of periodic acid reagent. With periodic acid at $25/lb., cost of oxystarch is about $30/lb. In the new process, the small initial charge of periodate is continuously regenerated and reused. Estimated production cost: 20-30¢/lb.

Cathode and anode compartments in the cell are separated by a semipermeable membrane. Cathode is iron or steel, catholyte is 5% NaOH solution. Anode is lead, coated with lead oxide; anolyte is 10% sodium iodate-periodate solution. Starch is fed to the anode compartment, is oxidized by the periodate to form two aldehyde groups in each repeating glucose unit.

Rotating furnaces: One negative vote

Union Carbide's disclosure to *CE* that its Electro Metallurgical division has just put in a rotating ferrosilicon furnace at Alloy, W. Va., while newsworthy, is not particularly startling, in view of:

- TVA's manifest enthusiasm for its rotating phosphorus furnace (*Chementator*, July 14, p. 74).
- Reports from Air Reduction that its four big rotating calcium carbide furnaces at Calvert City (*Chem. Eng.*, Mar. 1952, pp. 238-240) have run smoothly since startup.
- Latest tally by Elektrokemisk A. S., licensing agent for the basic Ellefsen patent, showing some 75 rotating furnaces for carbide and ferroalloys in operation or under construction all over the world.

What is more surprising is the information brought to light in the Monsanto-Miller trade secrets case (*Chementator*, June 2, p. 43) that Monsanto designed its first big phosphorus furnace at Soda Springs for rotation but two years later reverted to stationary design for its next furnace. Obvious inference is that Monsanto was disappointed in performance of the rotating furnace; however, the company declines to clarify this point.

Make better cost estimates, but fast

A way to improve the accuracy of "quickie" capital cost estimates was outlined last month by Shell Development's W. E. Hand at a meeting of the American Assn. of Cost Engineers in Cleveland.

Hand's method is a variation of Lang's ratio estimation technique described in *Chemical Engineering* ten years ago. In Lang's method, complete plant cost is approximated by multiplying total delivered cost of equipment by one of three factors. Choice of factor depends on whether the plant handles fluids, solids or both.

In Hand's method, each type of equipment carries its own specific multiplier, eliminating the sometimes arbitrary choice when using Lang's fluid-solid factors. Hand has worked out these typical multipliers to get total battery-limit costs (including indirects) attributable to each class of equipment:

Fractionating columns	4
Pressure vessels	4
Heat exchangers	3.5
Fired heaters	2
Pumps	4
Compressors	2.5
Instruments	4

With 15 years' experience using this method, Hand states that it has proved "quite satisfactory" for preliminary estimates, with better results than the Lang method. Because of company-to-company variations in standards for mechanical design and plant layout, Hand recommends that engineers using his estimation method work out multipliers which fit their own particular requirements.

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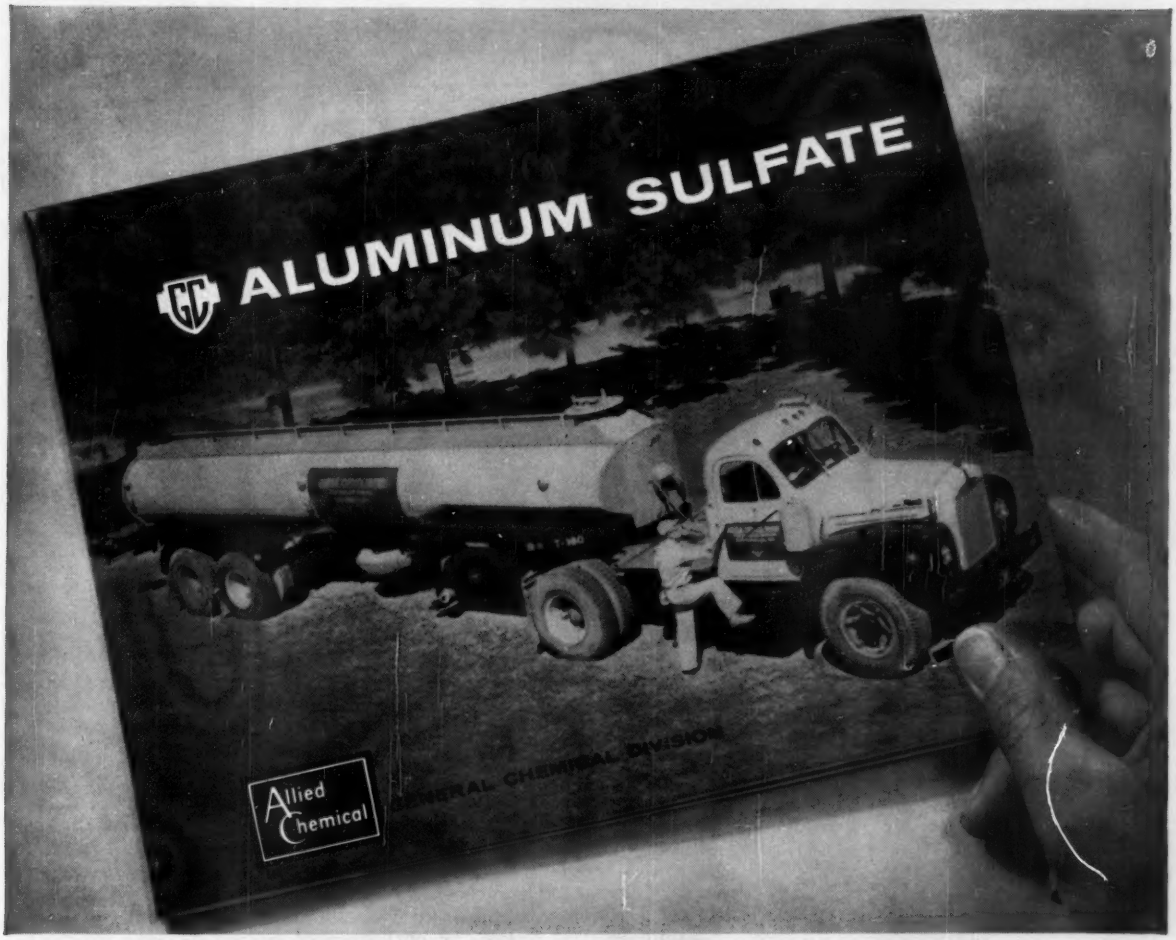

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Novel Reoxidation Scores Nitric Acid Gains

With new absorption-oxidation column, acid maker reduces cost of making nitric acid. Nitrous oxide reoxidizes more efficiently while bubbling through acid.

Along with the latest Paris fashions currently making their U. S. debut, another French design now bids for the attention of chemical engineers — and they'll probably find it more rewarding than the "trapeze look." Etablissements Kuhlmann, French chemical manufacturer, reveals for the first time details of its new scheme for producing nitric acid via ammonia oxidation.

If process lives up to all its advance claims, it could well be the most significant advance in nitric acid technology in many a year. Built around a novel absorption-oxidation column, process requires a smaller capital investment and turns out nitric at a lower cost per pound than competing processes, claims Kuhlmann.

As a corollary, process boasts over-all yields of around 98% while producing a 70% acid. By comparison, Montecatini's process, now making its initial U. S. appearance, claims 94-95% yields producing a 60% acid (See *Chem. Eng.*, May 5, 1958, p. 56).

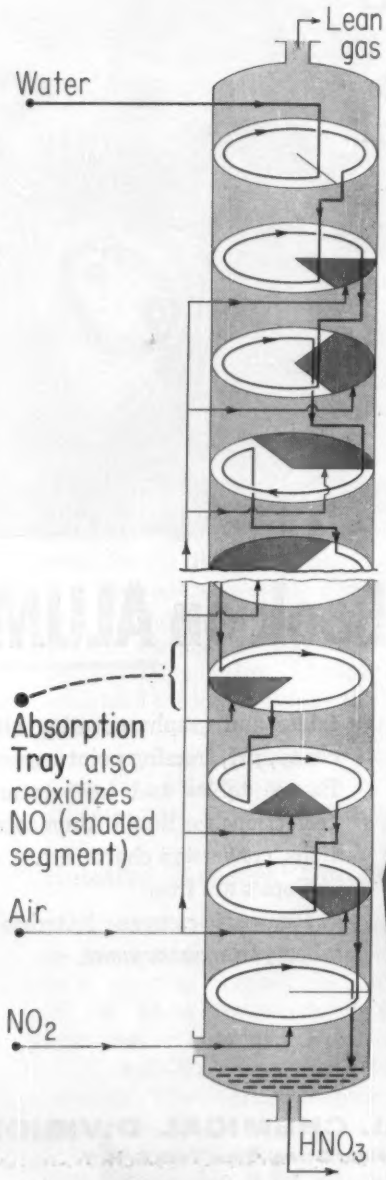
Kuhlmann is proving out its process in a 200-ton/day plant at La Madeline-lez-Lille and has accumulated over a year of operating data to back up its claims.

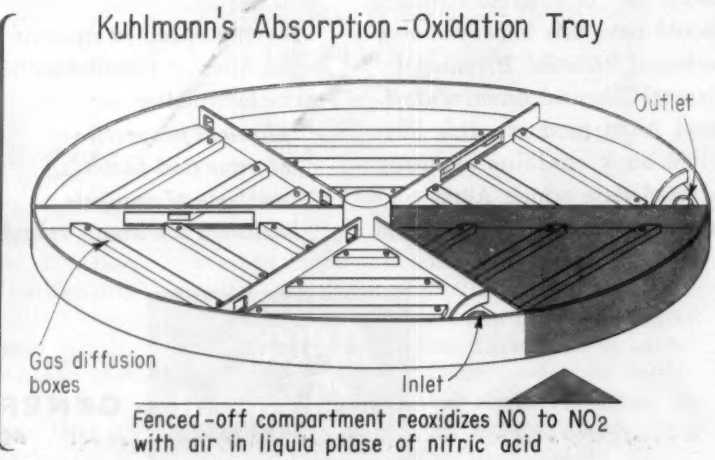
▶ **Liquid Holds Secret** — One look at the basic absorption equation reveals the impetus for Kuhlmann's development:

$$3\,NO_2 + H_2O \longrightarrow 2\,HNO_3 + NO$$

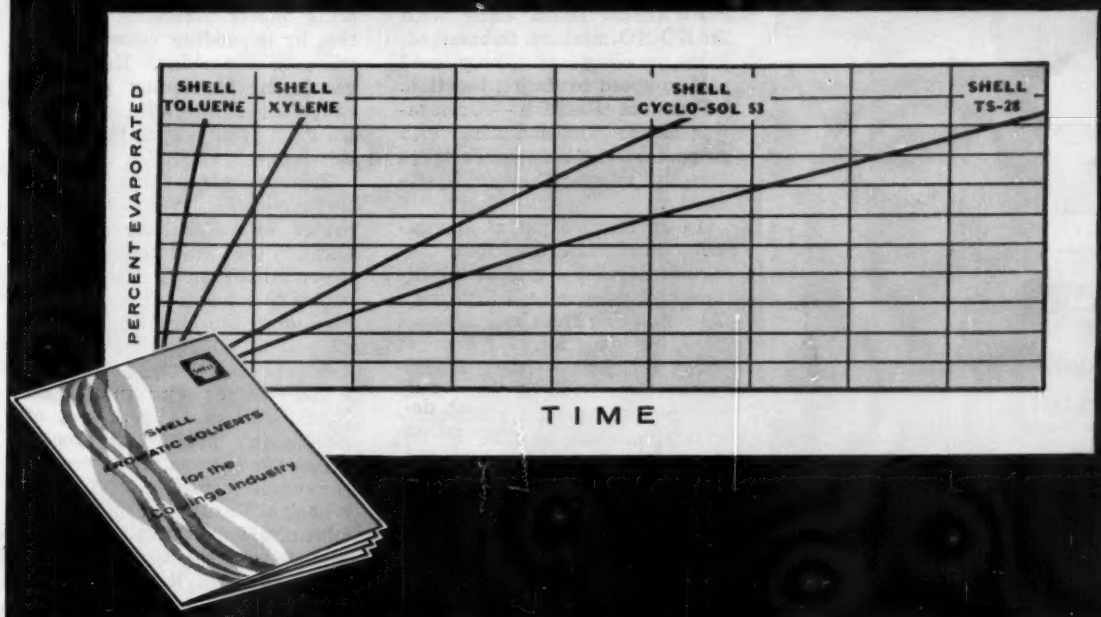
Each mole of nitrous oxide formed during absorption must be reoxidized to NO_2 before it can be absorbed. In conventional systems, this reoxidation takes place in the gas phase when air is injected into vapor space above liquid. This reaction is relatively slow and vapor volume needed controls the size of absorption equipment.

Kuhlmann discovered, however, that nitrous oxide reoxidizes almost instantaneously when mixed with air and bubbled through liquid nitric acid which is in equilibrium with the NO-rich gas. Utilizing this concept, Kuhlmann engineers were able





For industrial finish formulation...



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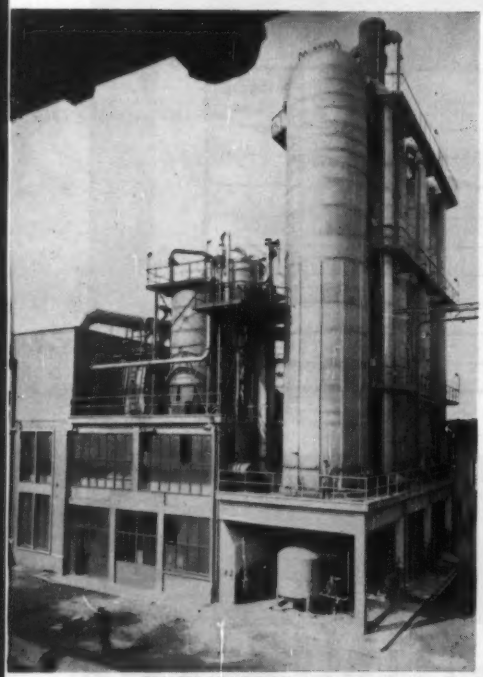

KUHLMANN'S columns give its nitric process an edge over competitive plants.

to design much smaller absorption equipment for the new plant.

▶ **Pie-Shaped Compartments** — Patented in France, Great Britain and Germany, Kuhlmann's novel absorption tower provides simultaneous oxidation of NO and absorption of the NO_2 into weak acid within separate compartments on each tray.

Separators divide each tray into six pie-shaped compartments. One or more of the compartments is formed by solid separators; the others are bounded by separators perforated with slots, staggered to mix the liquid as it flows in circular path from one compartment to another around the plate. Three perforated diffusion boxes, working like bubble caps, bubble gas from below through the liquid in each compartment.

The compartment(s), isolated by solid separators, functions as an oxidation zone. Acid in such a compartment, which is in equilibrium with NO-NO_2 stream from next lower plate, is essentially stagnant.

Air is introduced through the gas-diffusion boxes along with the NO-NO_2 mixture. Submerged, brine, cooling coils keep acid cool to speed oxidation reaction.

▶ **Premium Position** — Orientation of the oxidation zones with respect to those on other trays directly affects absorption efficiency.

In an English patent application, Kuhlmann describes tray positioning for a typical 16-tray tower: Tray numbers 2 through 7 (numbering from bottom) each have one oxidation compartment (tray 1 is just a simple absorption tray). Each of these compartments, comprising one-sixth of tray surface, is offset by 60° from oxidation zone on the tray below.

Tray outlets are placed so that NO_2-enriched gas from oxidation zone of lower tray bubbles up through most concentrated acid (near outlet) on the next plate. This relation of most-concentrated gas contacting most-concentrated acid maximizes mass transfer through gas-liquid interface.

Plates 8-14 in Kuhlmann's hypothetical column have two oxidation compartments (⅓ of tray surface), displaced by 60° from zone below. Thus, there is a partial overlapping which effects a double reoxidation as the gas stream becomes leaner in nitrogen oxides. Tray 15, identical to trays 2-7, completes cycle of double reoxidation and the final tray (16) is a simple absorption tray.

▶ **Rest of Flowsheet** — Remainder of Kuhlmann's two-pressure plant at La Madeline is based on standard nitric acid practice.

Ammonia is oxidized catalytically at atmospheric pressure with an efficiency of around 98.5% (pressure processes get only 96-98% oxidation efficiencies).

Hot reaction gases pass through a waste-heat boiler and then through an exchanger to heat exhausted gas from absorbers entering recovery turbine. Then, cooled reaction gas containing nitrogen oxides is compressed to around 40 psi., given additional refrigeration and piped to the absorption-oxidation columns.

Compressing gases before absorption reduces size of equipment needed and permits recovering power following absorption by expanding reheated gas through a turbine. Kuhlmann uses same absorption pressure range as Montecatini process; Du Pont process operates in 120 psi. range.

Exhaust gases from last absorption-oxidation tower are reheated in an exchanger placed ahead of the compressor and then expanded through a turbine connected to compressor. Low pressure drop through the system (7 psi. at 70% HNO_3, 4.3 psi. for 56% acid) makes possible a net power gain in process. Nitric unit can supply rest of Kuhlmann's plant with process steam after providing power for the compressor.

▶ **Look at Results**—The La Madeline nitric plant uses four of the new absorption-oxidation towers, about 70 ft. high and 15 ft. in dia.

Kuhlmann claims that absorption efficiency has averaged 99% since startup in June, 1957, with peaks as high as 99.5% for periods of a whole month. Efficiencies of 98-98.5% are considered about par for conventional nitric plants.

And 70% acid is considerably more concentrated than product from conventional plants. Usual acid strength is around 56-58%; most plants can boost this to around 60-62% with a resulting drop in process efficiency. Montecatini reports that it is now building a plant to produce 70% acid, but this plant will require an additional low-temperature absorption stage (with 98% efficiency), higher working pressure and extra refrigeration equipment.

A 70% acid is especially useful in making complex fertilizers—there is less water to evaporate. In making concentrated 98-99% nitric, too, a stronger starting acid makes concentration more economical.

Mine on Stilts Will Win Frasch Sulfur

By 1960, according to plans recently announced by Freeport Sulfur Co., one of the world's largest sulfur mines will be sitting on steel piers out in the

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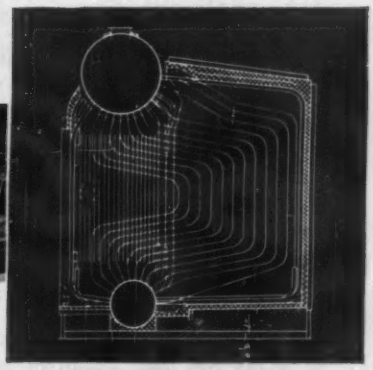

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63,700	150	Sat.	225	No. 6 Oil	83.7	0.5% Moisture Carryover
68,000	620	Sat.	350	No. 6 Oil	80.9	1 ppm Solids Carryover

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Gulf of Mexico. Construction has already started on the $30-million installation located seven miles off the coast of Louisiana.

When completed, all facilities will be perched 55 ft. above the surface in water 50 ft. deep—making what is believed to be largest steel island as well as the first offshore sulfur operation. Island will be Y-shaped, with drilling platforms at two of the extremities and a large heating plant at end of third arm. Total length of the Y's three arms will be almost one mile. A third drilling platform will be located a few hundred yards from main island.

Heating plant will be largest unit on the island—consuming 13 million cu. ft./day of gas to heat 5 million gal. of seawater to 325 F. for injection into the undersea sulfur formation. Plant will also compress large volume of air to air-lift sulfur 2,000 ft. to surface and will produce electric power for drilling rigs and other equipment.

This island will be home-away-from-home for 260 workers who will work five days on and then have five days off, transported to and from mainland in company helicopters.

Because offshore drilling rigs can't be easily shifted around as is done on land, each drilling unit will handle about 108 wells by using directional drilling.

Russians Will Utilize Compressed-Gas Work

Soviet engineers will recoup electrical and refrigeration energy by utilizing work previously wasted in dropping pipeline pressure from 16 atm. to about 4 atm. (*Chem. Eng.*, July 14, p. 71).

An experimental installation now under construction near Kiev will consist of turbines, a generator, heat exchangers and refrigeration equipment.

Two turbines, using gas heated to 70-90 C. at 17-18 atm., will be capable of producing 575 kw.; gas from the turbines will be routed to a distribution station and from there to the city gas mains.

Hammer Mill Knocks Down Pulping Costs

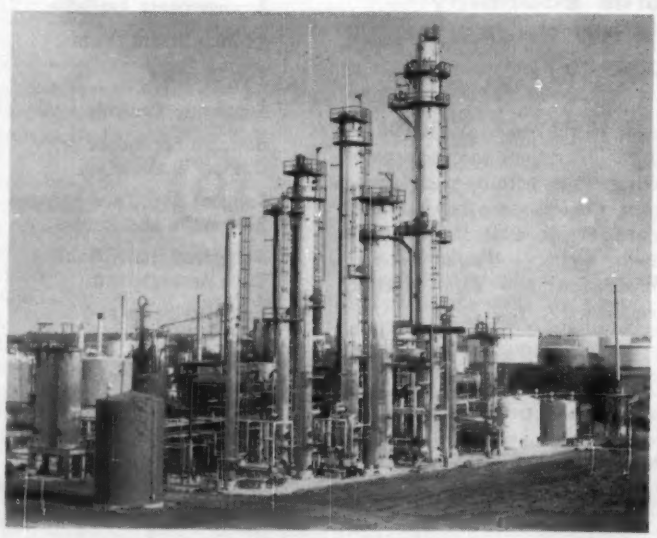
An invention by two professors of chemical engineering at Louisiana State University is now giving a Cuban sugar refiner a profitable outlet for mountains of sugar cane residue and is integrating a preliminary pulping operation with sugar mill production.

In the past, pulp made from bagasse (residue of sugar cane stalk after juice has been extracted) has been relatively expensive because it has been necessary to remove pith and dirt from stalks to make a pulp comparable to other standard stocks. Often the expense of cleaning up bagasse stock has priced it out of the market.

Now a modified swing hammer mill, called the Horkel depither, is being used at the Central Trinidad sugar mill in Cuba to remove pith and dirt from bagasse right as it comes from the mill. Depithing right on the spot lowers handling and shipping costs because of the reduced weight and pulping costs diminish because of shorter cooking times and higher yields.

At the Trinidad mill, two depithers handle a total of 250 tons/day bagasse (dry basis). Cane residue is fed by conveyor into one end of depither housing and travels length of rotor across the top of revolving hammers. Depithed fibers discharge onto a conveyor at other end of housing and travel to baling station. Pith drops out bottom of housing and is conveyed to sugar mill boiler house for use as fuel.

Horkel depither, invented originally by P. M. Horton and A. G. Keller, is now licensed for manufacture by Parsons & Whittemore, Inc.



Oil Firm Launches Into Petrochemicals

Vickers Petroleum Co. has started up its $3.5-million Udex extraction plant at Potwin, Kan., that will produce 15 million gal./yr. benzene, toluene, xylene and aromatic petroleum solvents. Vickers expects that the plant will pave the way for firm's further diversification in petrochemical field.

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"KARBATE" EQUIPMENT DEFEATS CORROSION

National Carbon Representatives expand your Engineering Force

E. R. HOGAN,
SALES ENGINEER

After graduating from Lehigh University with a B.S. in Mechanical Engineering, Mr. Hogan spent two years in the engineering department at National Carbon's Fostoria plant. Here he worked on the design and installation of equipment for the manufacture of carbon and graphite.

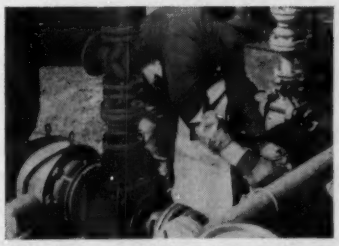
For the past 5½ years Hogan has been a sales engineer in the western New York and Pennsylvania area, working with chemical, steel and electrochemical industries on the application and use of carbon, graphite and "Karbate" impervious graphite materials.

"Karbate" Heat Exchangers to be shown at Heat Transfer Conference

National Carbon's complete line of "Karbate" impervious graphite heat exchange equipment will be on exhibit in Booth 28 at the Second National Heat Transfer Conference and Exhibit. This event, jointly sponsored by A.I.Ch.E. and ASME, will be held at the Edgewater Beach Hotel in Chicago, Illinois, August 17th thru 20th, 1958.

"Karbate" impervious graphite provides dependable, economical performance in tough corrosive services.

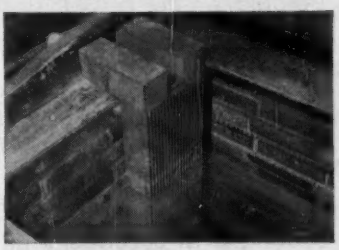
Pumping Nitric-Hydrofluoric Acids



The almost universal corrosion resistance of "Karbate" impervious graphite permits efficient handling of both individual and mixed acids. This is proved by the performance of a "Karbate" type F centrifugal pump in a nitric hydrofluoric pickling solution (16-18% HNO_3, 4% HF) at a temperature of 140° F.

While metallic pumps failed in this service in a matter of weeks, the wet end of the "Karbate" unit is in excellent condition after *six months service.*

Heating Nitric-Sulfuric Acids



High heat transfer rates, freedom from corrosion and exceptionally rugged construction make these "Karbate" impervious graphite plate heaters an excellent choice for tough heating services. One such unit (replacing a metal heater that lasted only a few weeks) has given *two years trouble-free service* in a nitric sulfuric acid pickling solution at temperatures of 170° to 180° F.

Based on this performance, 18 additional units have been ordered for the same application.

Cooling Sulfuric Acid

Eight to nine years' service with "Karbate" cascade type coolers in sulfuric acid service has been reported by three separate users. The resistance of "Karbate" impervious graphite to corrosion and to thermal shock makes this and similar performance records typical. The equipment is easy to clean and maintain and is sectionalized to permit installations of additional cooling surface. Since "Karbate" impervious graphite resists all concentrations of sulfuric acid up to 96%, these units are ideally suited for cooling of diluted strong sulfuric acids.

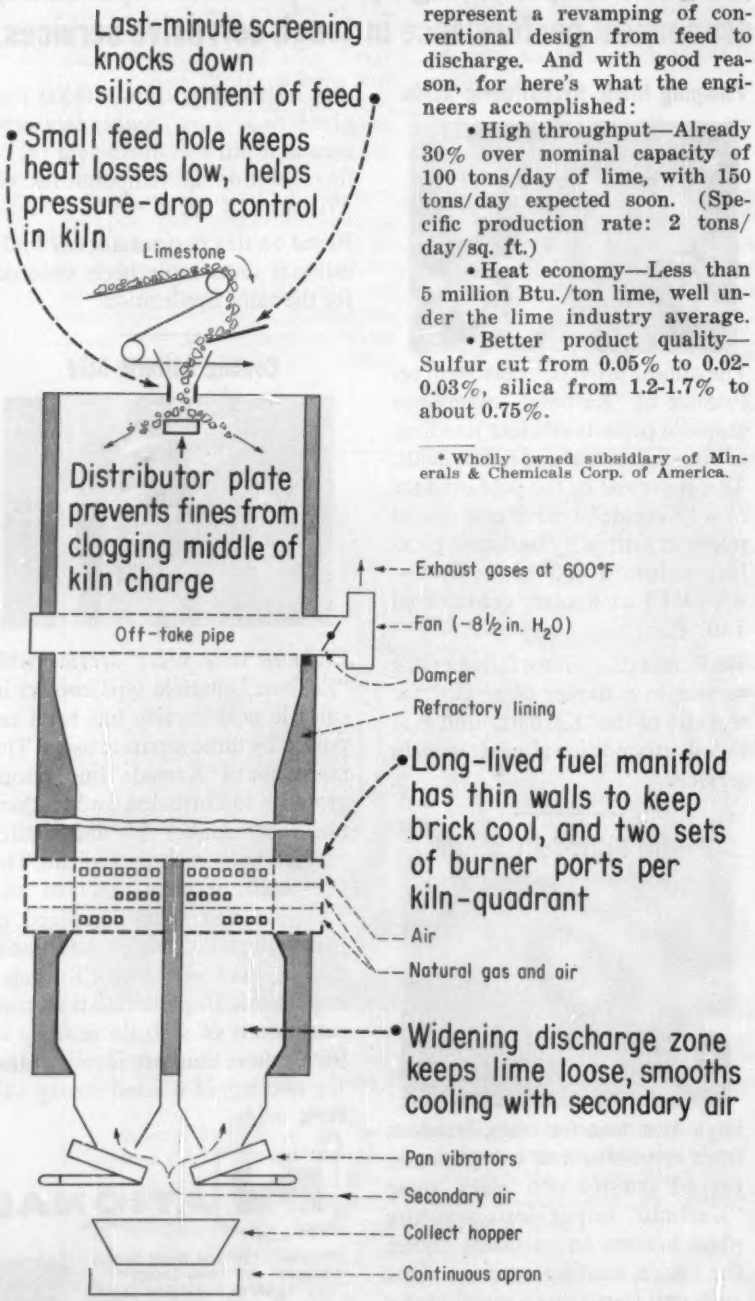
NATIONAL TRADE-MARK

"National", "N" and Shield Device, "Karbate" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

UNION CARBIDE

Revamped Kilns Smooth Lime Burning

Improve heat transfer in a kiln and you make life easier all down the line. Here's how Chemstone's new 100-ton/day lime kilns get results.



Chemstone Corp.'s* new shaft lime kilns at Strausberg, Va., represent a revamping of conventional design from feed to discharge. And with good reason, for here's what the engineers accomplished:

- High throughput—Already 30% over nominal capacity of 100 tons/day of lime, with 150 tons/day expected soon. (Specific production rate: 2 tons/day/sq. ft.)
- Heat economy—Less than 5 million Btu./ton lime, well under the lime industry average.
- Better product quality—Sulfur cut from 0.05% to 0.02-0.03%, silica from 1.2-1.7% to about 0.75%.
- Less manpower—Requirements for four kilns cut from six men to two.
- Long-lived burners — Still on stream after a year.
- Low pressure drop — Induced draft of 8½ in. H_2O.

* Wholly owned subsidiary of Minerals & Chemicals Corp. of America.

▶ **Control Heat Transfer** — You can tell from the design of Chemstone's new kilns that a kiln operator's most rugged problem is to control heat transfer. Most of the improvements built into the new equipment are aimed at licking it.

A final screening of limestone feed removes last traces of dirt and degradation products which might segregate in the kiln, cause channeling of gases and uneven heat distribution. Some of the fines are silica, which not only can carry through the kiln into the final product but can fuse around limestone particles to hinder complete calcining.

A small (14-in.) feed hole with a tight door admits belt-conveyed limestone with minimum leakage of air, heat losses and upset of draft control.

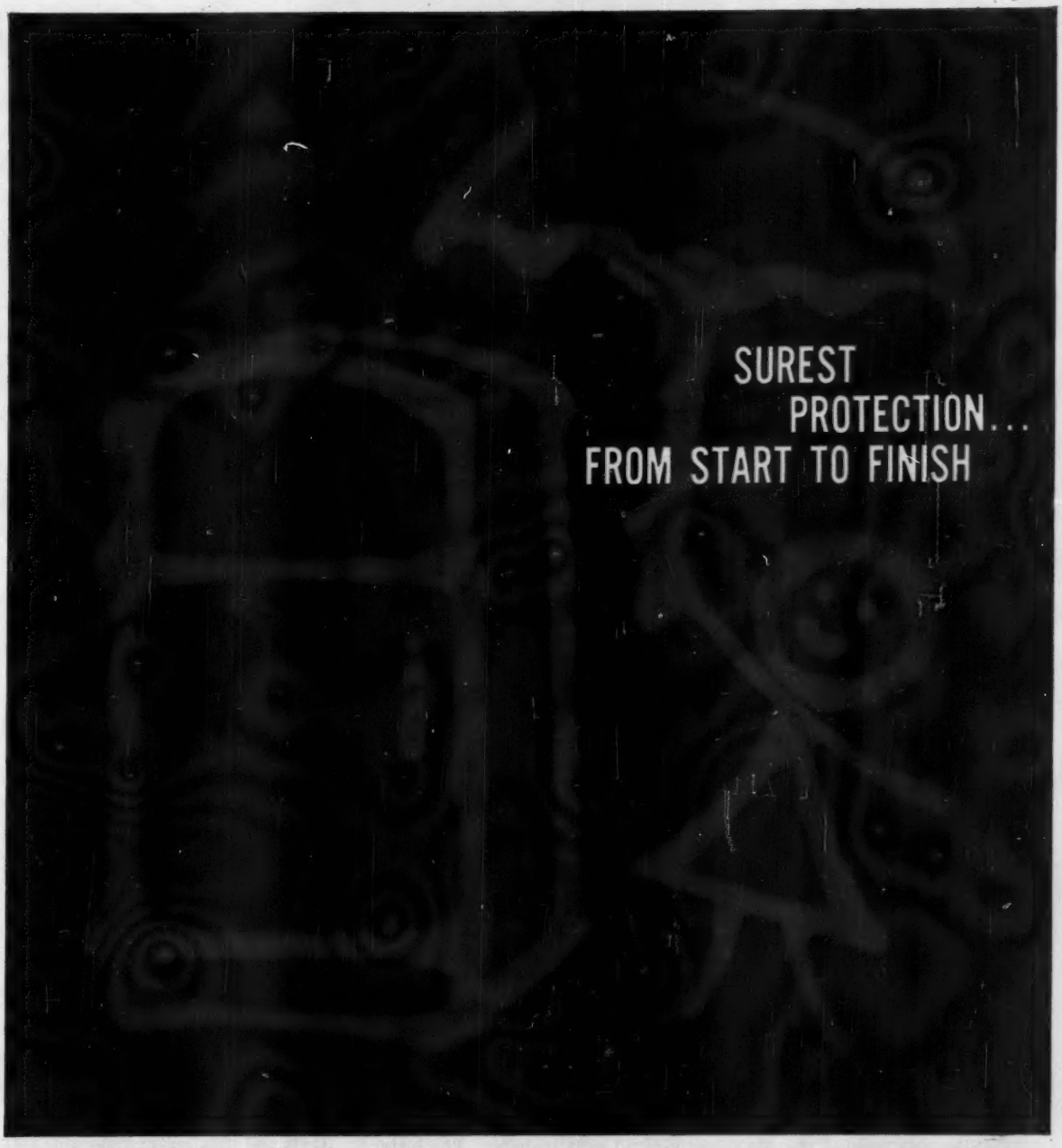
A circular distributor plate deflects feed toward the kiln walls, keeps fines from clogging up the middle of the charge.

Thin-walled burner construction permits good heat transfer from combustion zone to incoming fuel. Refractory burner walls remain relatively cool and resistant to abrasion.

▶ **Spread the Flame**—Combustion zone is divided into quadrants, each served by two groups of four burner ports. One group leads out from the center; the other leads in from the periphery of the charge. This setup gives eight burner groups—and eight adjustment spots—for flame application in the combustion zone.

Cooling zone below combustion chamber widens to keep lime particles (finer than limestone) from packing too tightly for free passage of secondary air on way to burners. The more efficient the cooling is here, the less secondary must be introduced to the combustion zone.

Close draft control in a nearly



Like all Esso Petroleum Solvents, Solvesso 100 is unsurpassed in its class for uniformity and purity. It assures top performance from force-dry finishes on countless home appliances and other products. Solvesso 100 is the perfect companion for the other outstanding ingredients used to assure the best results in all protective finishes.

The entire Solvesso group of aromatic solvents sets performance standards *throughout* the paint and surface coatings industry. Besides top quality, these products offer a most reliable source of supply and *immediate* delivery from key distribution points with Esso's excellent customer service and modern handling methods. For the surest protection from start to finish, *always* specify Esso Petroleum Solvents. Write, wire or telephone today! Esso Standard Oil Company, 15 West 51st St., N. Y. 19, N. Y.

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High-Quality Aromatic Solvents covering the full range of industrial needs

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PETROLEUM SOLVENTS

NEW KILNS cut operating labor requirements by two-thirds.

airtight system smooths out the entire burning pattern. A pressure drop of 8½ in. H_2O overall, and ½ in. H_2O across the combustion zone, brings in an optimum volume of secondary air.

▶**Don't Hang, Slip**—All these measures, in short, enable Chemstone to run its new kilns on the principle of "slip" rather than "hang."

In "hang" operation you weld a portion of limestone and lime to the kiln walls from time to time with a blast of heat. This suspends the whole kiln charge while you probe the interior with rods to check the reaction pattern—which may well be irregular. Then you discharge sections of material which appear to be completely calcined. Thus the charge may move through the kiln in rather lopsided fashion.

To operate via "slip" the charge must move down the kiln fairly evenly. Discharge can be continuous because the quality of material is pretty uniform across any section of the kiln.

Obviously, when hung material is loosened it doesn't do the brick lining any good. And the big probe ports shock the brick with cold air.

As odd as hanging sounds, it's an old, old practice in the lime business. Only the most thorough engineering can safely get around it.

▶**Feed and Screen**—Chemstone uses vibrating-conveyor feed to the new kilns—rather than hopper-car loading—to permit screening, introduction of charge through a small opening, and use of a distributor plate.

The limestone presently mined by Chemstone is outcrop material of high chemical quality, but mechanically contaminated with dirt and clay. As the limestone particles degrade during handling and sizing, these impurities are continuously exposed as relatively fine material. Last-minute screening gets most of this stuff out. In fact, Chemstone credits this one step with shaving the silica content way down in the final product.

Kiln feed holes are so small that the fan needs no compensation to maintain desired draft during charging periods.

▶**Natural Gas Helps**—Chemstone has really cashed in on availability of natural gas in the Strausberg area.

It pipes the fuel at 6 psi. into burner ducts, where it mixes with air and ignites at the ports. Because the gas is far richer than, say, producer gas, much less is needed; you can use smaller ports and more of them.

Smaller ports detract little from the strength of the burner walls, which are thin to permit rapid heat transfer. The latter, in turn, holds brick temperature down, preserves its strength.

"We haven't had a central burner failure yet," says Chemstone's chief engineer, William Roberson.*

Another thoughtful measure: Burners are not an integral part of kiln lining; they can expand or contract freely.

▶**Kiln Criteria**—Each kiln's capacity is, nominally, 100 tons/day of lime. But each has handled 130 tons/day and is figured to get up to 150 before long. (Running at top capacity helps the "slip" by minimizing overheating and hanging of the charge on the kiln walls.)

Heat requirements are less than 5 million Btu./ton lime. Exhaust temperatures of 600 F. and lime temperatures of less than 300 F. attest further to good heat utilization.

Better burning shows up in product quality, too. Sulfur and silica contents are way down in the lime. And Chemstone says other lime producers literally handpick their product to eliminate incompletely calcined material.

Ruling out handpicking saves a couple of men right then and there. This saving, plus better over-all control, enables two men, instead of six, to cope with four high-capacity kilns.

* Chemstone's first two kilns, built in the spring of 1956, were shut down a year later for repairs to the kiln lining. Burners were replaced at the same time. The second pair of kilns went on stream last summer, are still going strong.

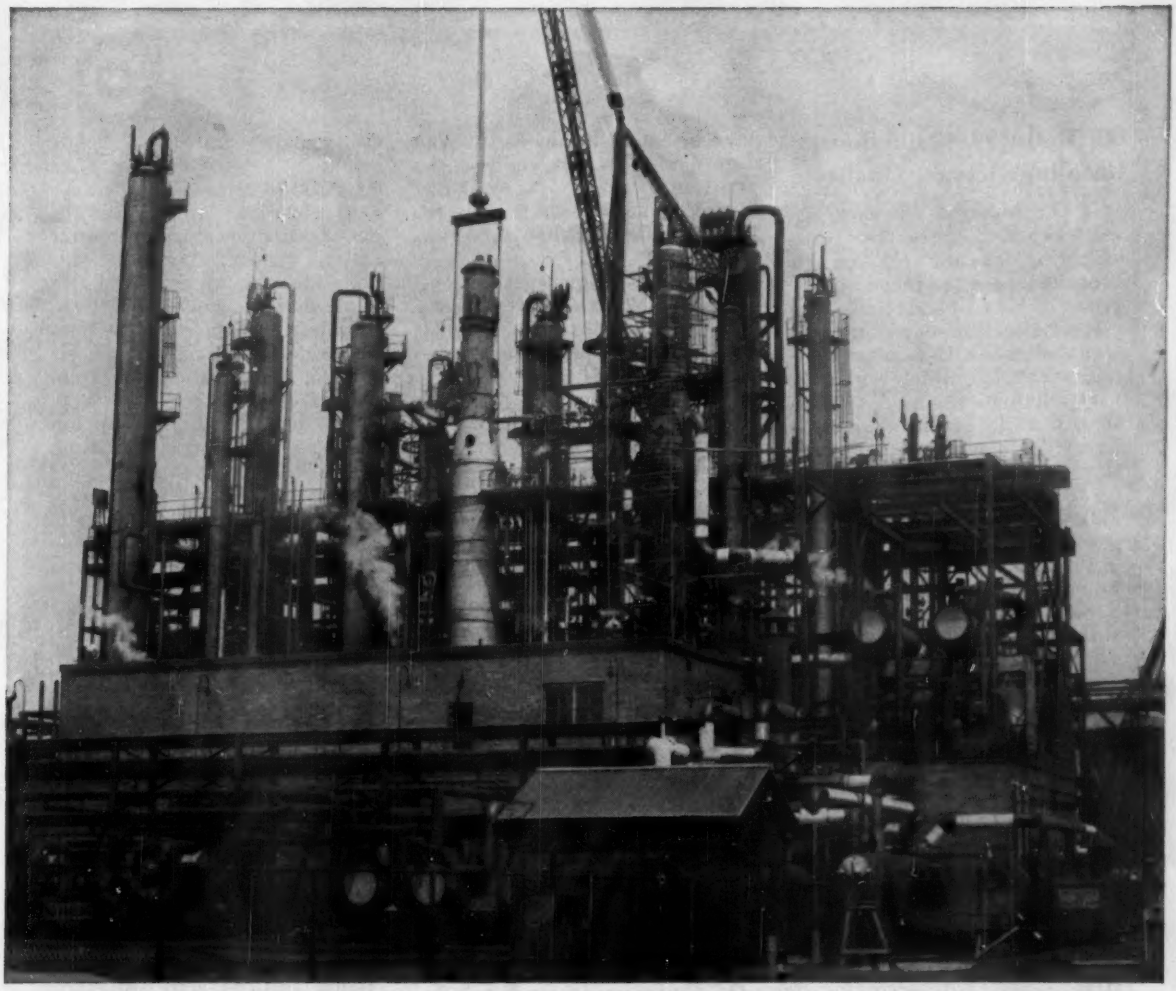
Oil Hydrogenation Wins Role in New Gas Plant

England will build a 5-million-cu.-ft./day plant in the Bristol area for producing commercial gas via direct hydrogenation of light petroleum distillates—third plant to use oil hydrogenation scheme developed by F. J. Dent (*Chem. Eng.*, Mar. 24, p. 58).

In Bristol plant, process will operate at about 450 psi. Feedstock will first be vaporized and sulfur removed by a molybdenum catalyst and iron oxide purification. Vapor will then be hydrogenated with an 80% H_2 gas stream in fluidized coke bed.

Gas from top of reactor will also yield several byproducts—ligroin, naphthalene and petroleum coke. Product gas, with byproducts removed, will be a blend of hydrocarbons, hydrogen and diluent with total heating value similar to standard commercial gas (about 500 Btu./cu. ft.).

Novel feature of the Bristol plant will be method of generating hydrogen: A portion of product gas from reactor will be reformed with steam in a fluidized bed of nickel catalyst. Reformed gas will consist mainly of hydrogen and carbon monoxide.



Erecting the all-welded, two-part chromium-nickel stainless steel recovery tower at Gary chemical works of United States Steel Corporation. Graver Tank & Mfg. Co., Inc. of East Chicago, Indiana, fabricated the 90-foot tower and tested it to pressures of 162 psi and 246 psi.

Stainless steel tower goes up...corrosion comes down... in recovery of aromatic chemicals from coke oven gases

This chromium-nickel stainless steel tower recently took over an important job at the Gary Steel Works Coke & Coal Chemicals Div. of U. S. Steel. The big vessel receives hot absorption oils from other parts of the processing plant . . . puts them through its six-tray light oil section, and 15-tray light oil stripper . . . recovers benzene, toluene, and xylene.

It's a productive but highly corrosive process. So corrosive that it knocked out a carbon steel tower in relatively short time. That's why for its replacement the Gary Works decided on Type 304 ELC chromium-nickel stainless steel. This nickel-containing stainless steel can take the corrosive effects of these gases and chemicals . . . it assures *long* service life.

For your corrosion problems, it will pay you to consider nickel-containing stainless steels. They are highly resistant to a wide range of organic and inorganic chemicals.

* * *

A 34-page booklet, "Corrosion Resisting Properties of the Austenitic Stainless Steels," is available to you upon request. If you'd like a copy, simply write:

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Oil Refiners Again Boost Gasoline Octane, Quality

In the wake of two new developments, pressures are mounting on oil refiners to boost octane and otherwise improve quality of gasoline.

A bold tack in marketing was signalled when D-X Sunray Oil Co., with $12 million worth of new refining equipment now on stream at its Tulsa, Okla., refinery, retrieved the gauntlet thrown down by Tidewater Oil Co's. claim in marketing the "highest-octane premium and regular" gasoline.

Product quality, explains Sunray, is the sole purpose in adding equipment. New facilities won't add one gallon to the refinery's 75,000-bbl./day capacity, but will make it "capable of producing the highest-octane gasoline produced anywhere."

New units are a 20,000-bbl./day naphtha Unifiner, 12,000-bbl./day Platformer, butane-isomerization unit to produce 2,400 bbl./day of isobutane for alkylation and a hydrofluoric acid alkylation unit to turn out 2,500 bbl./day of 105-octane gasoline blending stock. So far, Sunray is limiting processing to 105 octane, but, according to Harry A. Brown, manufacturing vice-president, it "will be ready for years to come" to satisfy higher-octane gasoline requirements.

▶ **Esso Ups Quality**—A different approach, taken by Esso Standard, emphasizes a different aspect of gasoline quality.

Esso's new-formula gasoline, now at dealers' pumps, claims to be cleaner burning because high-boiling paraffins have been removed.

New-formula gasoline, Esso claims, doesn't have to be as high in octane to equal performance of other gasolines.

First U. S. Town to Get Water Desalting Plant

First water desalting plant to serve a U.S. city is scheduled to go into operation this November at Coalinga, Calif., an oil and farming center of 6,000 people in the San Joaquin Valley. Just a few months ago, it looked as though Key West, Fla., was going to be first city to get its drinking water from salt-water sources (*Chem. Eng.*, Feb. 10, 1958, p. 72).

Desalting plant, built by Ionics, Inc., of Cambridge, Mass., will demineralize town's brackish water supply at an estimated cost of $1/1,000 gal. Dissolved solids content will be sliced from 2,000 ppm. down to 290 ppm. at a rate of 28,000 gal./day.

Previously, city's water had to be brought in by rail from Armona, some 45 mi. away. Coalinga's director of public works, Reginald O. Phelps, estimates that the new unit will save the town $400,000 in the next ten years.

Ionics' process freshens brackish waters containing 1/30 to 1/3 as much salt as sea water but which are still undrinkable. An electric current draws salt ions through a special plastic membrane, leaving desalted water behind. Fresh water is continuously pumped to city for distribution; salts are flushed away as weak brine.

New Process Chops Cost Of Concentrating Nitric

Hercules Powder Co. has abandoned the conventional sulfuric acid process for concentrating nitric acid and has erected a novel 50-ton/day magnesium nitrate concentration system at its Parlin, N. J., plant. Major gain in the switchover is a lessening of corrosion problems with resulting drop in investment and operating costs. And Hercules can now market a close-to-c.p. nitric (over 99%) at technical-grade prices.

Engineered and built by Badger Mfg. Co. and proved in a year of operation, here's how the new Hercules process works: To build up magnesium nitrate in system initially, a charge of magnesium carbonate and 60% nitric acid is fed to an evaporator. Concentrated to about 72%, nitrate salt is piped at 215 F. to a tray tower. Keeping nitric acid concentration in the magnesium nitrate down to 0.1% is key to sidestepping several serious corrosion headaches.

▶ **Ready to Go**—Dilute nitric acid (60-61%) then feeds to dehydration tower at same level as salt stream. Magnesium nitrate absorbs water from dilute acid so that acid above feed tray is more concentrated than azeotropic mixture and almost-pure nitric distills over from top of column. Nitric acid is condensed, cooled and a portion recycled to absorption column for reflux.

Magnesium nitrate bottoms, at 55-70% concentration and about 350 F., is concentrated to 72% in flash evaporators and recycled to column. Losses are virtually negligible and Hercules engineers feel salt will last almost indefinitely without contamination.

Hercules, very happy with economies of new concentrating system, is planning to license process both in U.S. and abroad. Firm cautions one limitation of process, however: Process must start with fresh dilute nitric to give sulfate-free concentrate. A plant with plenty of sulfuric acid available that is processing recovered nitric would be better off with conventional sulfuric acid process.

News Briefs

Refining: Magnolia Petroleum Co. is completing an expansion program worth "many millions of dollars" at its Beaumont, Tex., refinery. New units include a second alkylation unit to produce about 8,000 bbl./day of alkylate, a 30,000-bbl./day Sovafiner, and a unit to recover hydrogen sulfide from alkylation feed stocks.

Molybdenum, alloys: American Metal Climax, Inc., is building a $1-million plant at Coldwater, Mich. to produce molybdenum and molybdenum-base alloys. Plant, with capacity to produce more than 800,000 lb./yr. of castings, will include two consumable-electrode melting furnaces developed by American Metal Climax.

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YOUR FUTURE BEGINS with an arc and a line, with dimensions and specifications. How your future *extends* from these plans on paper depends largely on the skills and facilities of the men who build from these masterful markings.

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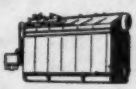

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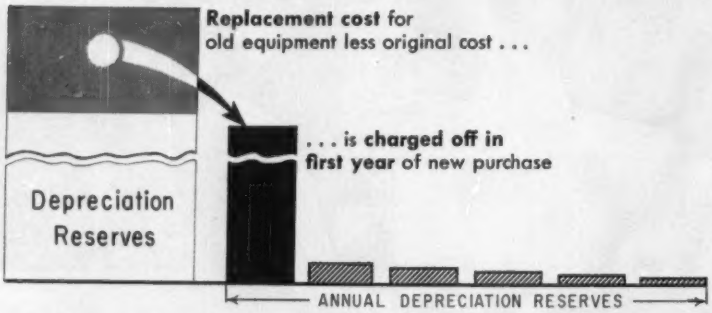
Depreciation: There'll Be Some Changes Made

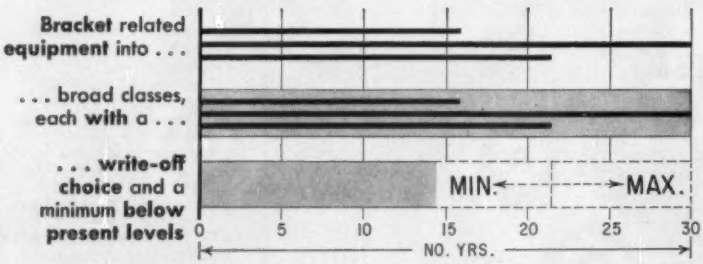
1. **Inflation has made replacement cost for equipment greater than original cost.**
2. **Technology change has made economic life of equipment less than legal useful life.**

Replacement Cost Recognized in Peloubet Plan



Economist M. Peloubet's reinvestment - depreciation - allowance plan deals in replacement of dollars rather than goods. Assume $100,000 equipment is retired 20 years later and that the cost index for equipment has gone up 130%. Theoretically, replacement will cost $130,000 more than original buy. According to Peloubet, the rise may be immediately charged off as depreciation against an investment in new depreciable property made within two years of old asset's retirement. It must, however, be subtracted from the depreciation base of the new investment.

Legal Useful Lives Condensed by Bracket Plan



The bracket system would dispense with a separate useful life for each and every kind of equipment by grouping all equipment in a limited number (10-15) of broad classifications. Each bracket carries a range of useful life within which the taxpayer is free to choose. And in all brackets minimum useful life is considerably less than present legal useful lives.

Co-sponsors of the plan: *American Machinist* and National Assoc. of Machine Tool Builders.

DEPRECIATION provisions of the federal tax law are moving toward liberalization. Whether or not Congress prescribes much in the way of tax-reform medicine this year, there should be some changes within the next couple of years which will affect chemical engineering evaluations of a project's cost.

You may even have to readjust your thinking sooner than that. For the accounting profession is beginning at last to feel that "the current dollar cost of depreciation should be reflected in some manner in corporate reports to stockholders."

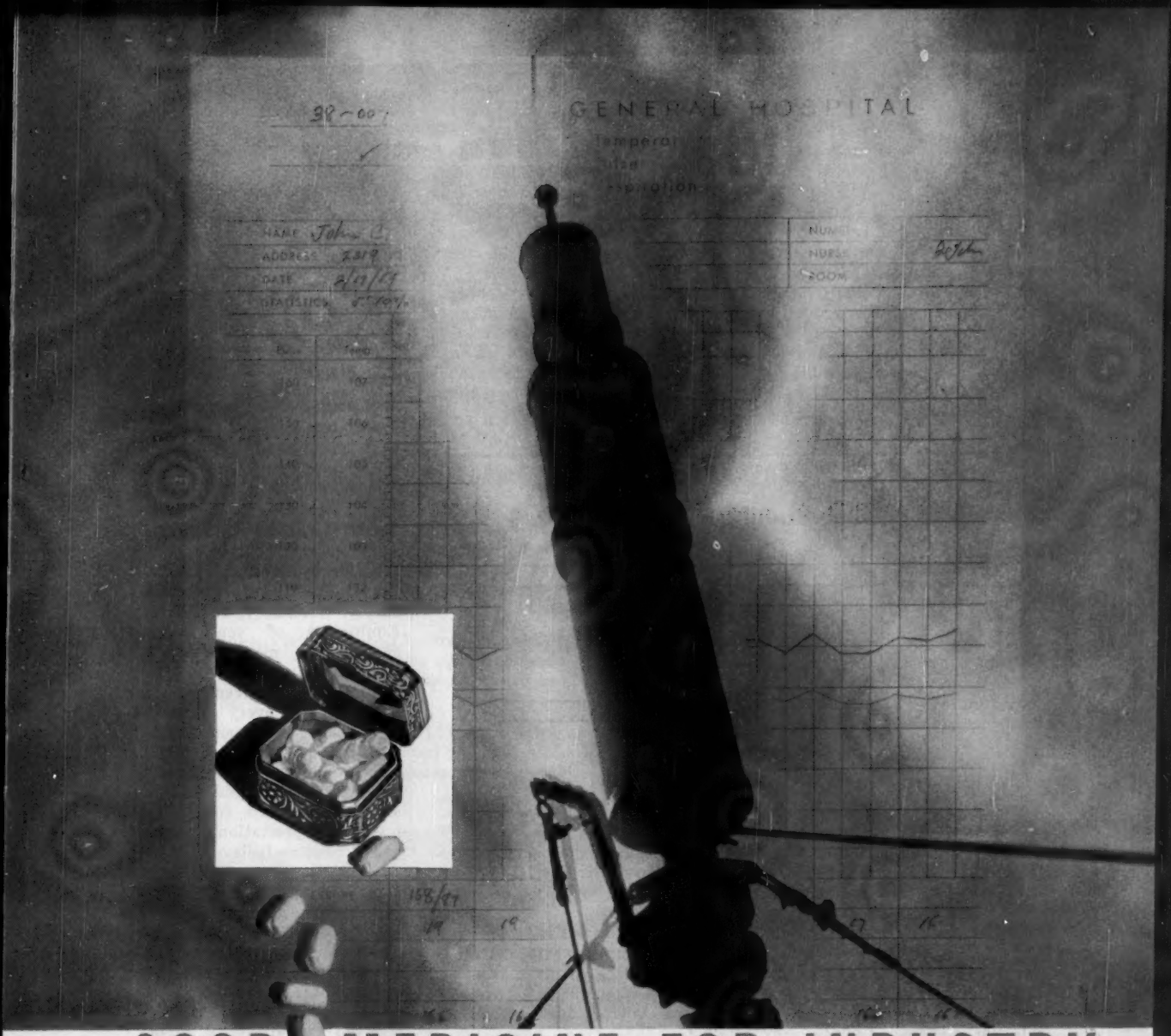
▶ **Different Figuring** — Thus, your project evaluations for internal consumption may have to recognize this mounting sentiment for depreciation changes even though, when your company sits down at the table with Uncle Sam, the rules of the tax game may still be the same.

Dissatisfaction with current depreciation practice is voiced in two arguments:

- Original cost of equipment bears little relation to original cost. In times like these—when prices for construction and equipment are rising—the sum of deductions based on an asset's original cost falls short of providing enough money to finance its replacement.
- Legal useful life bears little relation to economic useful life. In times like these—a period of rapid technological change—a machine may become obsolete several years before it is physically worn out.

Arguments for more liberal depreciation regulations are offered in the name of economic stimulation at a time when capital expansion—a prime bulwark of the economy—is lagging badly.

Several proposals have met with some approval. Some are short-term, stop-gap measures (p. 72); if they don't make the



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Pentaerythritol is a polyhydric alcohol in white crystallized form. Its principal use is in the production of alkyd resins and rosin esters, which account for over 9/10 of current applications. As a major producer of PE in three grades (technical crystals, pure crystals and technical pellets), Celanese is basic in the raw materials required for this useful industrial chemical.

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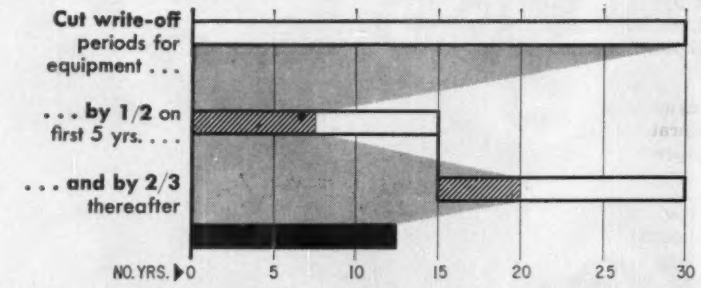
grade before the economy starts to snap back, they'll probably be shelved.

Other plans (p. 70) are aimed at long-term reform. As such, they—or others like them—have a pretty fair chance of popping up in depreciation calculations even if the economy perks up.

▶ **Dollar Replacement** — Peloubet's reinvestment-depreciation-allowance scheme (p. 70) is both intriguing and praticable. It deals in replacement of dollars rather than replacement of myriad kinds of equipment. It doesn't give away depreciation bonuses (at great cost in federal revenue) in order to offset rising costs.

Peloubet's plan merely speeds up deduction of depreciation, permitting a taxpayer to meet rising replacement costs as a charge against taxable income when he needs the money the most, the year of purchase.

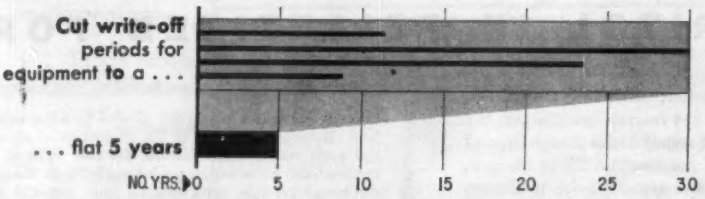
Capehart Bill Trims Useful Lifes by 1/2 to 2/3



The Capehart Bill proposes to substantially reduce depreciation periods for capital investments made or contracted for between Jan. 1, 1958 and June 30, 1959. Under this measure—sponsored by Senator Homer Capehart (R., Ind.)—depreciation periods would be cut in half for the first 15 years of estimated useful life (according to Bulletin F of the Internal Revenue Code). Any portion over 15 years would be slashed by two-thirds.

This concession would apply only to assets with a useful life of at least three years, and only on construction put in place within 18 months after construction is begun. However, delivery may take place within a reasonable time after 1959 if there's a written contract during 1958 or 1959.

Five-Year Write-Offs Step Depreciation Payments



The five-year plan would permit rapid write-offs on all purchases of durable productive equipment during an 18-month period. The idea is to fight the current recession with the same device—five-year amortization—used by the U. S. since 1950 to spur construction of defense production facilities. Co-sponsors of the plan are National Assoc. of Machine Tool Builders and *American Machinist* magazine. NAMTB proposes that Jan. 1, 1958 to June 30, 1958 be the effective period; *American Machinist* recommends June 30, 1958 to Dec. 31, 1959.

The Case Against Easier Depreciation

PROPONENTS of more liberal depreciation rules for tax purposes are numerous, vocal, and undoubtedly correct—to a degree. But there are good arguments against using replacement cost as a basis for depreciation allowances and against shortening present legal useful lives.

Equipment of replacement may have the same name and general function — but it is nearly always better than its predecessor on at least one of several counts: productivity, maintenance, durability, safety, versatility, flexibility. Equipment of replacement *should* cost more, even in terms of constant dollars.

▶ **No One-Way Street** — Secondly, nearly every commodity—not only the goods a company buys but the goods it sells—costs more now than it did 10-20 years ago. Impassioned arguments for inadequacy of depreciation reserves would have us believe that inflation affects only the things firms must pay for.

Furthermore, accountants contend that depreciation is traditionally a means of recovering the (original) cost—no more, no less—of durable equipment.

Even the argument of obsolescence-before-payout is two-sided. There are many examples of capital goods which retain their productivity beyond their legal life.

▶ **Everybody's Problem** — In no other form of investment—save, perhaps, common stocks—is there any assurance of equivalent purchasing power at payoff time.

Why single out corporate capital investment for protection? The most valid answer—one free from self interest—may come under the heading of national necessity. We may have to give corporate investment a better guarantee if we are to keep our economy strong and growing.

Alemite "Tri-Duty" air line controls!

All-New...for the cleanest, driest, best-regulated air line lubrication

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Automatic Air Line Lubricator! Provides automatic lubrication to air-operated mechanisms. Air stream controlled by compensating Venturi valve. Nine-ounce capacity.

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2. Visual Oil Counter. Oil sight dome in lubricator permits visual observation and count "per-drop" of lubrication.

3. Uniform Oil Mixture. Regardless of air pressure and volume!

4. Consistent Output. Oil and air mixture proportionately constant.

5. Easily Installed. Straight "inline" pipe connections . . . ½" p.t. inlet and outlet ports.

6. Wide Oil Range. Handles all viscosities of oil up to 500 SSU at 100° F.

7. Continuous Operation. Oil reservoir is refillable while unit is in operation.

8. Instant Oil Feed. For intermittent or continuous tool operation—no lag!

9. Filter Oil Tube. Removes all contamination from oil passing into air line.

10. Concentric Venturi Design. Assures constant, uniform mixture of air and oil.

11. Contamination-Free Air. Removable strainer in Air Regulator traps minute dirt particles.

12. Effective Control of Air Flow. Air Regulator eliminates excessive pressures and sudden surges.

13. 100% Condensate Removal. Water Separator removes and automatically dumps 100% of the condensate present in air lines.

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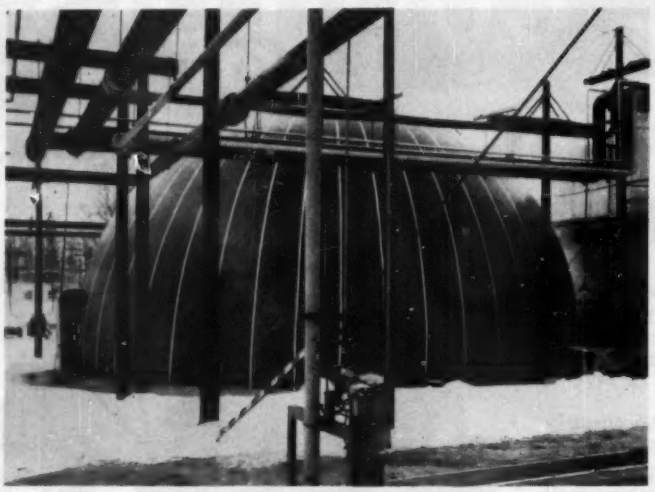


Neoprene-Nylon Bubble Shields Tank Cars

Bubble of 8-oz. nylon coated with neoprene protected three tank cars set on a strip of track during a severe Michigan winter.

The 58-ft. diameter shelter was held erect by maintaining a small amount of air pressure within the unit. It was kept inflated by a static air pressure of ¾ in. of water furnished by two 2,000 cfm. blowers.

The building is designed to withstand winds up to 75 mi./hr. Heated to keep inner temperature at 40 F. while it was 20 outside, bubble also withstood 96.4 in. of snow that fell—Du Pont Co., Wilmington, Del. 74A

Flocculant

Higher in purity, increased solution clarity, more uniformity.

Dow is superseding all production of well-established flocculant, Separan 2610 (*Chem. Eng.*, May 1957, p. 162), with an improved polyacrylamide-type flocculant, Separan NP10.

Improvements include higher purity, increased solution clarity, greater product uniformity. Like its predecessor, it is effective over a wide pH range. It is expected to pick up Separan 2610 markets in filtering, thickening and clarification processes in the mining, pulp and paper, chemical processing, water treatment and miscellaneous industries.—**Dow Chemical Co., Midland, Mich. 74B**

Cracking Catalyst

Combats heavy metals contamination in refineries.

A newly-developed fluid cracking catalyst is now available in commercial quantities. Designed for selected refinery situations in which certain operating conditions—such as heavy metals contamination—exist, it will be sold as part of the company's Aerocat series.

Extensive testing on principal types of gas oils has shown it to have outstanding physical and catalytic properties. Priced at $225/dry ton, it is designed for service in new and existing facilities.—**American Cyanamid Co., New York. 74C**

Glass Paper

Silicone-resin treated insulation, thin, flexible class H material.

Electrical insulation, made from long glass fiber paper containing no cellulose fibers, can be impregnated or coated with silicone resin to suit prospective application.

The impregnated product, in tape or sheet form, can be used as a physical support, a medium for later impregnation with other compatible resins, and adhering spacer, as a wrapper in multiple winding machines and field coils.

The coated product, in sheet form or as a wide tape, can generally be used as a layer insulation. It is a good dielectric insulating tape for wrapping armature coils, and dry-type distribution transformer coils.

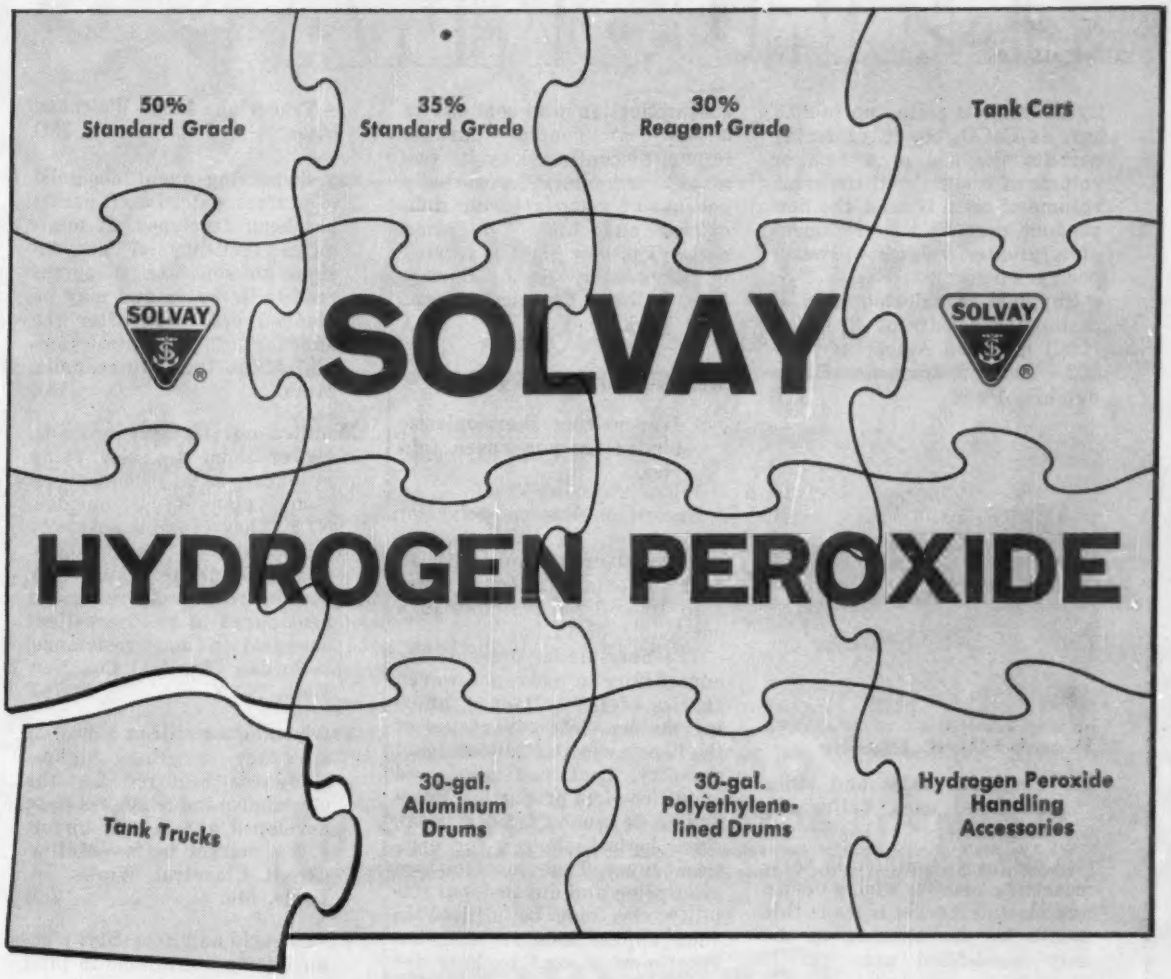
The treated glass papers have good physical handling characteristics such as flexibility and high tensile strength in the available low thicknesses.—**Westinghouse Electric Corp., Pittsburgh, Pa.**

Ion Exchange Resin

Treats water with contaminants of high molecular weight.

A new highly porous, strongly basic anion exchange resin has an unusually high volumetric capacity. It is recommended for the treatment of all waters containing high molecular weight organic compounds. Its porous nature provides for ready absorption of the large molecules, and for their ready release during regeneration.

When used in place of other ion exchange resin, high capac-



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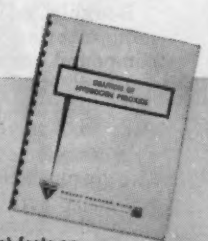

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ity of the new resin (up to 30.5 kgr. as $CaCO_3$/cu. ft. of resin) permits the use of a smaller volume of resin. Or, if the same volume of resin is used, the new product permits the treatment of a greater volume of water per cycle.

Supplied in chloride form at a shipping density of 45 lb./cu. ft., it is called Amberlite IRA-402.—**Rohm & Haas Co., Philadelphia, Pa.** 74D

Wood-Filled Plastic

For wall plates and other electrical uses, better arc resistance.

A bid for a 64-million-lb. thermosetting-plastics wiring device and closure market is made this month by the opening of the only wood-filled urea plastic plant in the country.

Roughly equivalent to phenolic in price, the new molding compound surpasses it in colorfastness and arc resistance (80 to 100 sec. ASTM arc resistance vs. 0 to 10 sec.). It is also said to cause less mold wear and to produce moldings which are more scratch-resistant.

In the packaging field, the new product will compete with about 30 million lb. of thermosetting molding compounds annually channeled to this, 12½ million lb. of which is alpha cellulose filled urea. It differs from the latter in that its filler is finely ground wood flour rather than bleached wood pulp. It is less expensive and its physical characteristics are comparable. It does not match alpha cellulose filled urea's color translucency or range.

The material, to be marketed under the Plaskon trade name, has not been produced in the United States since 1955. Previous production was confined to a low-cost general purpose brown, discontinued by its two major suppliers reportedly because of manufacturing difficulties and high processing costs. The new plant is located in Edgewater, N. J.—**Barrett Div., Allied Chemical Corp., New York, N. Y.** 76A

Binder for Fabrics

Low-melting, thermoplastic binder for non-woven fabrics.

Known as Dacron polyester fiber-binder, an undrawn, uncrimped Dacron staple with an average denier filament of about 8 to 10 will be available in a cut length of 1½ in.

The fiber-binder presents the opportunity to make non-woven fabrics of 100% Dacron, offering the complete advantages of the fiber's excellent dimensional stability, heat resistance and good electrical properties. Properties of such fabrics make them logical choices for electrical tapes. Their low moisture absorption and dimensional stability also may be utilized in such applications as inter-liners for suits and backing for coated fabrics.—**Du Pont Co., Wilmington, Del.** 76B

BRIEFS

Three silicone rubber compounds designed for fabrication of O-rings, gaskets and other seals have been developed. Designated SE-362, SE-372, and SE-382, these compounds meet or surpass the requirements of AMS 3303C, 3304B, and 3305C respectively.—**General Electric Co., Waterford, N. Y.** 76C

Mevalonic acid tagged with radiocarbon-14 for use in biochemical research is available at prices below those of other commercially available mevalonic acids. A possible precursor of cholesterol, squalene, and other terpenes and sterols, it was tested and found to be the purest available and also to exhibit complete microbiological activity.—**Tracerlab Inc., Waltham, Mass** 76D

Soy dispersing agent designed to perfect water-based paints has been developed. It minimizes tendency of suspensions to separate, disperses readily in water and may be blended before or after the addition of pigments.—**General Mills, Inc., Minneapolis, Minn.** 76E

Modified novolac epoxy resins, six of them are now being produced in a recently-completed plant at Bainbridge, N. Y. They range in viscosity from 2,000 cps to semi-solids. Called Epiphen epoxies, they can be room-temperature or heat cured to yield excellent chemical and heat resistance.—**Borden Chemical Co., New York, N. Y.** 76F

Semiconductor silicon metal, of a grade meeting highest standards required for the electronics industry, has been developed and is now undergoing market tests.—**Mallinckrodt Chemical Works, St. Louis, Mo.** 76G

Pivalic acid and neopentyl alcohol are now available in pilot plant quantities as part of a series of sterically hindered compounds. Their strongly hindered structure is believed to foreshadow commercial potential.—**Arapahoe Chemicals, Inc., Boulder, Colo.** 76H

Dye penetrant, called Spotcheck, is now available in nonflammable or very-high-flashpoint formulas. They are not made with carbon tetrachloride-base solvents, but with the safer chlorinated hydrocarbons.—**Magnaflux Corp., Chicago, Ill.** 76I

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about any item in this department, circle its code number on the

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CA ANNOUNCES

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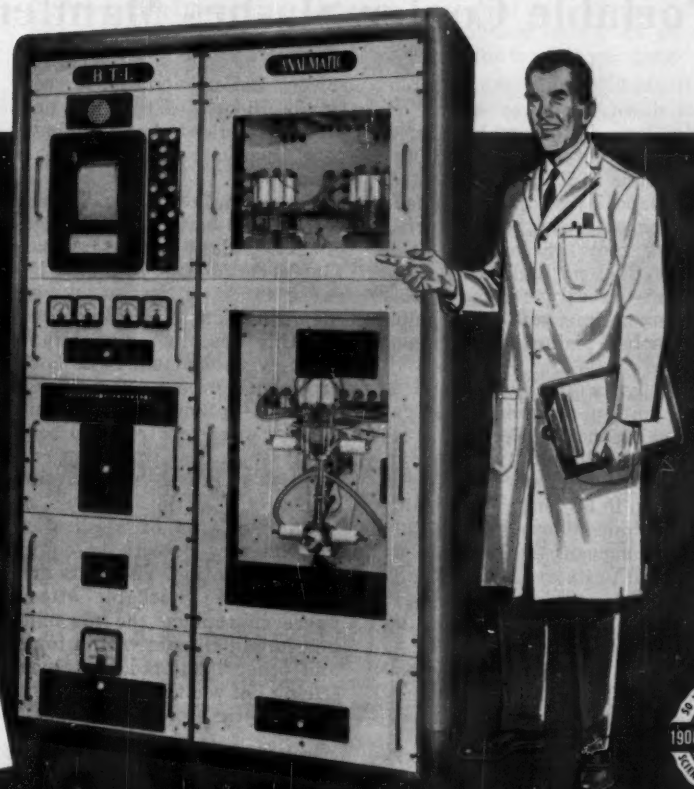

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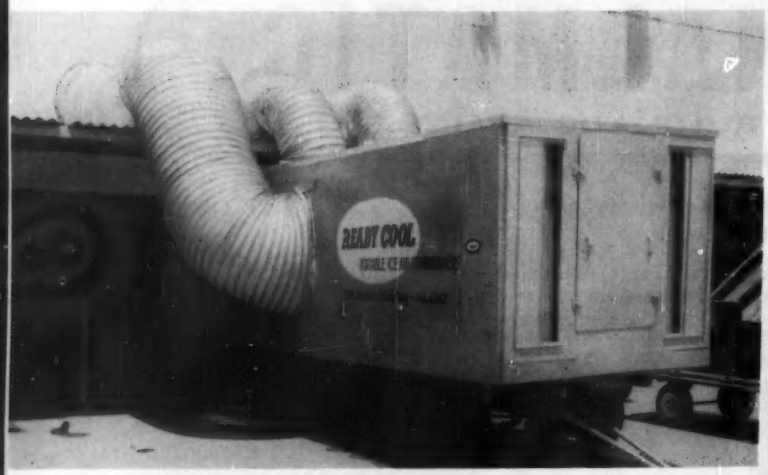
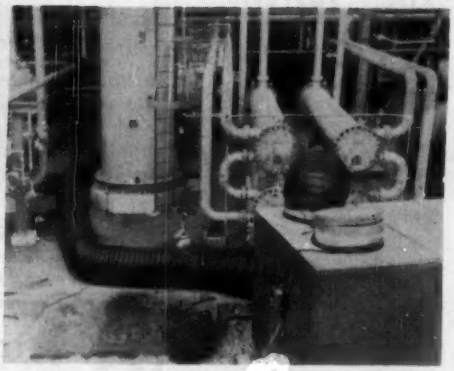




Compact, trailer-mounted unit delivers cool air to speed cooling-down time of heated equipment, provides more workable atmospheres within confined vessels.

Portable Cooler Slashes Maintenance Costs

Heated vessels must often cool down for many hours, or even days, before maintenance men can enter. This cooling-down time is frequently wasted time, especially during unscheduled or emergency shutdowns. A new tool for industry—the Ready Cool portable air conditioner—greatly reduces cooling-down time, and thus helps to combat rising maintenance costs.

Briefly, a Ready Cool is a combination air wash-coil system using melting ice as the refrigerant. Simplicity of design permits high-tonnage refrigeration (up to 60 tons) for low initial equipment cost (about $130/ton of capacity). The trailer-mounted units are entirely self-contained and are completely portable; temporary installation is quick and easy.

▶**Cooling or Ventilation**—Company officials claim that a Ready Cool unit will cool furnaces, towers, boilers and similar vessels in 10-30% of the time previously required. And they have case histories to back this claim.

The manufacturer cites the case of one user, a large petrochemical plant in East Texas, that secured a 50-ton unit because it was dissatisfied with the 70 hr. lost in cooling down cracking heaters for repairs.

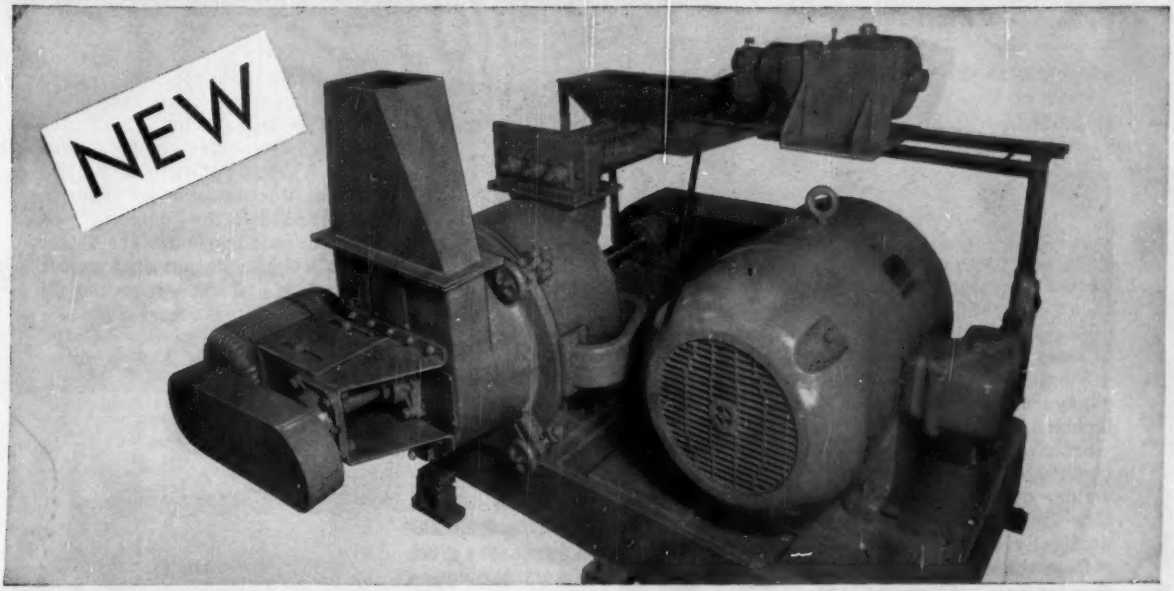
Ready Cool slashed the cooling-down period to 12 hr. average. The plant reported that heaters were repaired and back on stream in less time than previously required for cooling alone.

Another area of application for the new coolers is equipment ventilation. The units provide a more workable atmosphere to replace the normally hot, humid climate within tanks and other insulated containers during hot weather. In such situations, the cooler provides a large-volume, low-velocity supply of cool, dehumidified, ventilating air. This technique is especially valuable if the workers are garbed in protective clothing.

Reducing the heat load of the workers greatly increases efficiency and improves morale. One of the users reported a 40% savings in payroll alone when the 132 F. interior of an oxygen-plant cold box was ventilated with air conditioned at 72 F.

▶**Ice to Cold Air**—Major equipment items aboard the Ready Cool include a large insulated chamber capable of holding up to 4½ tons of ice, aluminum-finned copper coils, an all-bronze marine pump and a power unit. The power unit can be either an industrial internal-combustion engine or a 220/440-v. electric motor, depending on customer requirements.

In operation, circulating



FOR PRECISION GRINDING AND CLASSIFYING IN ONE OPERATION

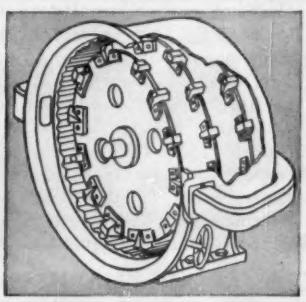
The PULVOCRON . . . An Air Attrition Impact Pulverizer and Classifier with Controlled Radial Inward Air Classification.

Now in one compact unit you can have a pulverizer and a classifier plus an automatic feeder, with separate controls over each. This assures positive particle size control and high capacity over a wide range of products. The Pulvocron will produce particle sizes from a range of 99% less than 5 microns or as coarse as 50 mesh, depending on the material and desired results.

The grinding chamber contains three adjustable plates with twelve staggered beaters on each. It also features added versatility through interchangeable liners of corrugated, perforated or smooth finish, plus variable rotor stator clearances.

The Classifier unit is on a hinged section with quick-open locks for simplicity of operating adjustment or cleaning.

Material is both ground and classified through high centrifugal pressures set up by the beater and classifier plates. The Pulvocron is designed with oversize returns for automatic feed back of any oversize for further grinding.



Grinding chamber with adjustable plates, removable liners and oversize returns.

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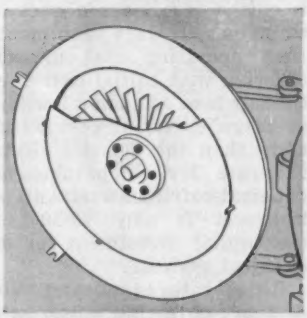

Classifier Unit with separate motor. Swings open as a hinged section with quick open locks.

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The **Strong Scott** Mfg. Co.

DEPT. CE-NPB6-645

Equipment Designed for Better Processing

451 TAFT STREET N.E., MINNEAPOLIS 13, MINNESOTA

water at 35 F. feeds through the air-cooling coils, where it picks up heat, and then sprays over the ice, which returns it quickly to 35 F.

Ventilating air flows through the water spray for preliminary cooling and washing, and then loses any entrained water as it passes through a standard throw-away filter. The blowers pull the air through the bank of coils for further cooling and dehumidification, and then discharge it via flexible duct to location.

In a few installations, air recirculates back to the cooler to reduce operating costs. The entire operation can be thermostatically controlled.

◂**Cost data**—Since the coolers use ice as a refrigerant, operating cost varies considerably with required tonnage. The manufacturer quotes an ice cost of about 26¢/ton-hr. Thus, a 20-ton unit operating at full capacity for an hour would melt $5.20 worth of ice, and for two hours, $10.40 worth. Depreciation is almost negligible, and power costs are extremely low.

This operating cost for continuous refrigeration could be considered quite high compared to other methods of air conditioning. However, if the need is only a few hours a week, or three or four days each month, then operating cost in combination with initial cost is extremely low. At such a low level of usage, operating cost is little more than the demand electrical rate for comparable mechanical refrigeration. And initial cost is only 20-30% of the capital investment for mechanical systems.

Rental rates to industry, more or less for testing purposes on a lease purchase agreement, are $300/wk. or $700/mo. For outright purchase, a 20-ton Ready Cool, which delivers about 6,000 cfm. air, is priced at $4,300; 60-ton coolers, delivering 18,000 cfm., cost $6,900 with gasoline power, and $7,400 with electrical. Other units, 30, 40 and 50-ton, vary accordingly. A 1-yr. factory guarantee goes with each unit.—**Ready Cool, Inc., 2301 American Bank Building, New Orleans, La.** 78A

Rescue Mask

Supplies air or oxygen to wearer on demand.

Bearing the name Short Snorter, a new full-face, quick-entry breathing apparatus gives complete respiratory protection to the wearer—in any toxic or oxygen-deficient atmosphere. Air or oxygen supply lasts 10-15 min.

Useful for inspection and maintenance procedures, or rescue work, the apparatus permits maximum freedom of movement. Total weight is only 15 lb.—**Globe Industries, Inc., Dayton 7, Ohio.** 80A

Power Supply

Provides a variable, controlled d.c. power source.

Remotely controlled by a self-saturating magnetic amplifier, each Model MS 708 silicon rectifier puts out 75 to 750 v. at 200 kw. Regulation accuracy is 1%, ripple is 2% RMS.

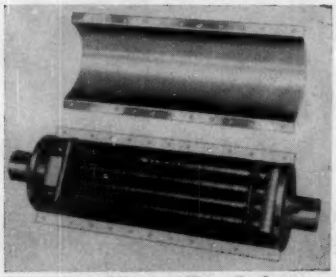
Up-draft air, drawn through the unit provides the necessary cooling. Air does not blow directly against the rectifier junctions. — **Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.** 80B

Fill-Height Inspector

Process control instrument applies radiation.

The new AccuRay System inspects the fill heights of packed containers moving along conveyor lines, and actuates rejection devices to remove any that are improperly filled. The system is accurate to ± in. of target fill level for packing rates as high as 1,000 containers/min.

Containers being inspected move between a long-lived isotope energy source and a detector. Variations in fill height cause fluctuations of energy received by the detector. A control unit translates the detector's voltage output into reject signals if and when container fill height violates preset limits.—**Industrial Nucleonics Corp., 1205 Chesapeake Ave., Columbus 12, Ohio.** 80C



Waste Heat Reclaimer

Exchanger uses waste heat for fluid heating.

A new heat exchanger of fin-tube construction reclaims heat from such media as exhaust steam, exhaust gases from gasoline or diesel engines, and other hot gases normally wasted by venting. In operation, hot gases pass over the finned surface of the tubes; heat-absorbing fluid flows through the coil.

Suitable for temperatures to 1,500 F., the unit is available in copper, aluminum or choice of steels. Sized to fit application.—**Rempe Co., 340 North Sacramento Blvd., Chicago, Ill.** 80D

Motion Indicator

Warns of improper equipment operation.

Connect the Roto-Guard to any turning shaft of equipment such as conveyors, elevators, feeders, etc., and you have a watchdog over proper operation. Should the rotation of the shaft slow below operating level, or stop entirely, this motion indicator will either warn

(*Continued on page* 152)

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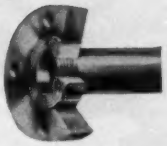
Faster than welding... *easier* than welding. A Speedline Insert Flange assures a leak-proof, *expanded* joint *every* time. Saves assembly time *and* costs!



Cutaway view shows pipe expanded into Insert Flange

2. LEAKPROOF UNION JOINTS

Speedline Unions are *gasket seated* to prevent leakage ... bi-metallic for easy make-up and disassembly without galling or seizing. Available in two types: PE for expanding or PW for welding to Sch. 5 or 10 pipe and Speedline Fittings.

Type PW—For Welding

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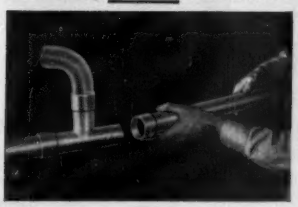

Speedline Aligning Connectors fit *over pipe ends* ... save time in aligning the most complex layout —permit preassembly *prior* to welding or brazing!

***PLUS* SPEEDLINE'S "EXTRA LENGTH" FEATURE**—There's an extra straight section on *every* end of *every* Speedline elbow, tee, reducer, bend and cross. This means extra clearance for welding and also facilitates joining with flanges or unions. Speedline Fittings, designed especially for use with Schedule 5 and 10 light wall stainless pipe, offer installation advantages and other cost savings not possible with conventional fittings. Write today for Speedline catalog or contact nearest Distributor.

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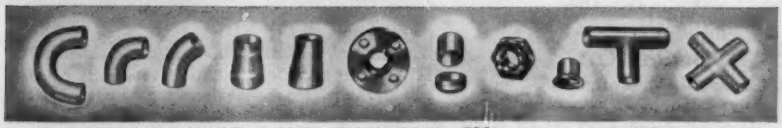
THE NEWEST THING IN PIPELINE ECONOMY



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®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

No oil filters.
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No internal lubrication to contaminate air handled.
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Non-pulsating pressure.
Original performance constant over a long pump life.
Low maintenance cost.

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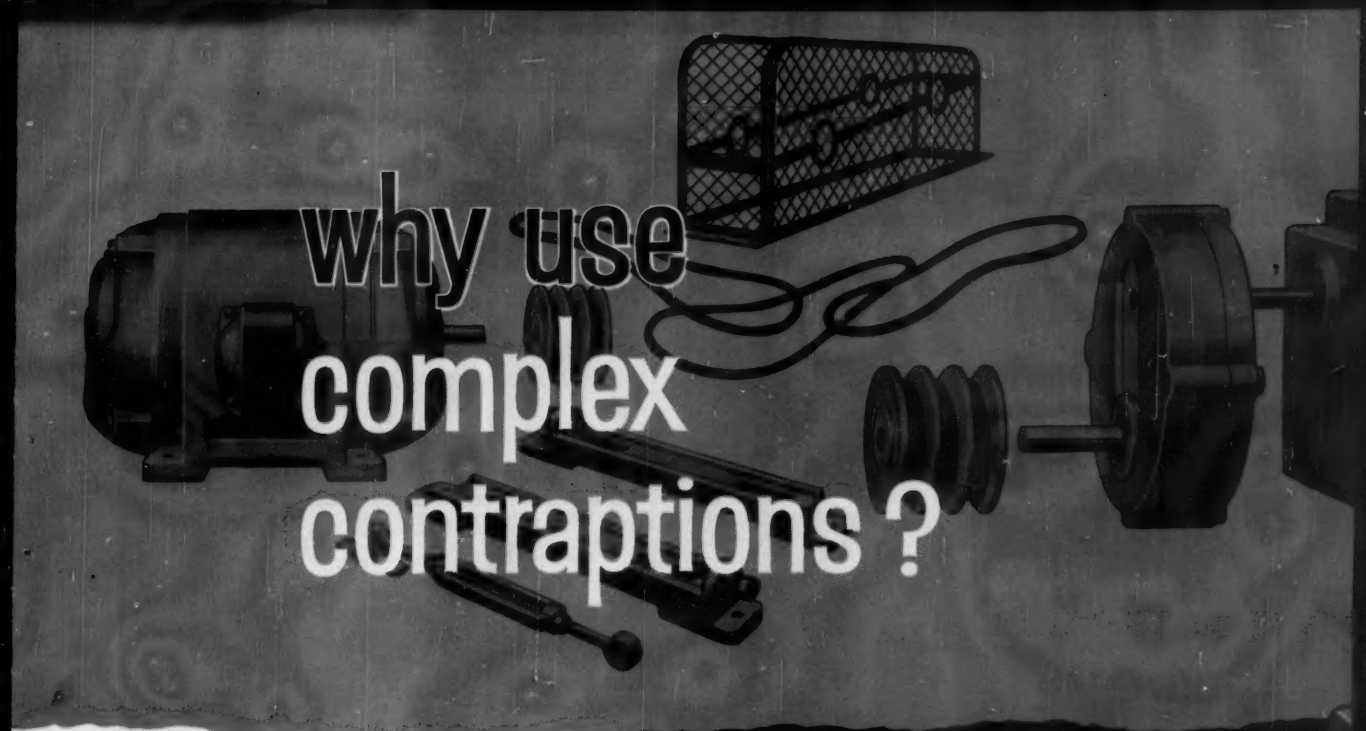

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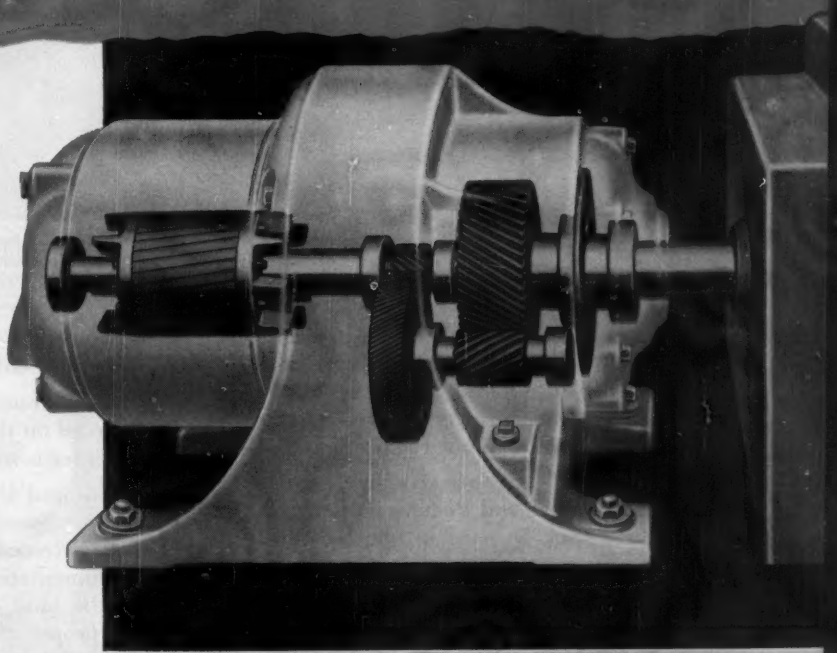

Don't trust your production to cumbersome contraptions that slip... misalign... and create operator safety hazards. Instead of buying a "unit" that requires belts, pulleys, separate motor, and turnbuckle or rails to be added at extra expense... instead of spending costly production time on recurring adjustments—take the easy, simple, economical way to geared power with U.S. Syncrogear Motors. Syncrogear Motors can't slip! Can't misalign! Can't endanger operator! They give you *positive* power delivery in one compact, self-contained package—steady slow shaft-speeds, permanent precise alignment, maximum efficiency and long life. Best of all, U.S. MOTOR dependability! Available in RATINGS 1/3 TO 30 H.P.

U.S. ELECTRICAL MOTORS INC.

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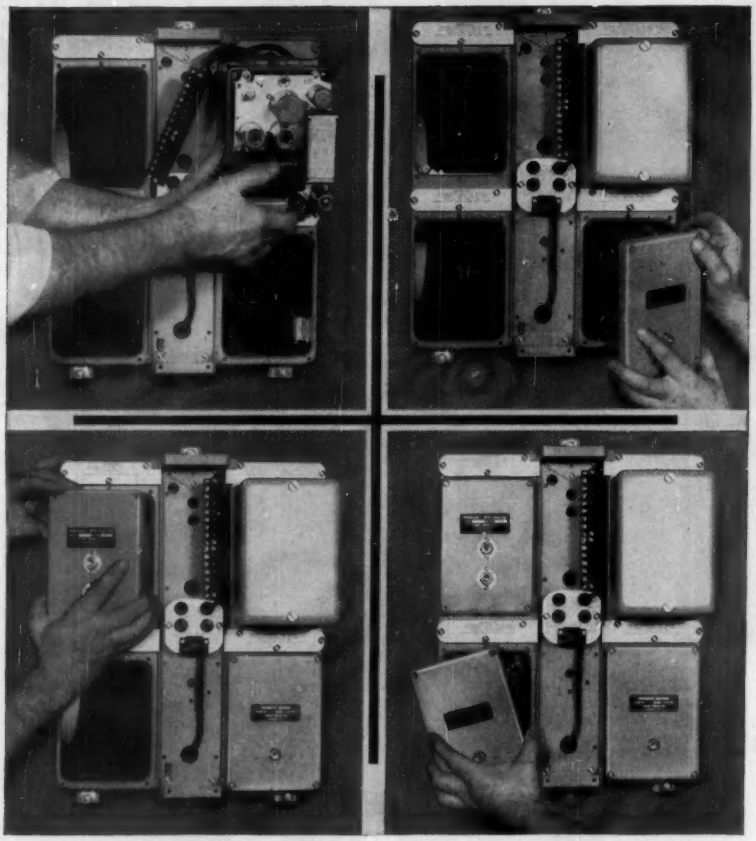
SEND FOR FREE 16-PAGE BROCHURE... illustrated in full color... on U.S. Syncrogear motors.

CUSTOM BUILD your own Bailey Recorder



These four views of the back of a Bailey Recorder show how four plug-in units may be added as needed to meet almost any recorder application.

The freedom and flexibility of "do-it-yourself" instrumentation is yours in the Bailey Recorder. A variety of plug-in units make it possible to record, control, and retransmit any variable that can be converted to a pneumatic or electric signal.

The basic plug-in units are the Bailey a-c and d-c Electronic Receivers and Pneumatic Receivers. Any four of these may be used in one recorder, intermixed in any way, to provide four continuous records on one chart.

For automatic control, other plug-in units are available.

For square root extraction or linear integration, there are two plug-in variations of the Bailey Integrator.

When you want a pneumatic signal that varies according to a pre-set pattern plug in a Bailey Program Controller.

Periodic running time of a condition or process is recorded on the chart when a Bailey Running Time Recorder is used.

These and other plug-in units are described in Product Specification E12-5. Some companies stock Bailey Recorder cases and assorted plug-in units. As instrumentation and control needs arise they build up the kind of recorder-controller required, using the proper plug-in units from stock. Unmatched versatility such as this means lower instrumentation costs.

For the complete story of how easily you can custom build this recorder to your needs, see your Bailey Engineer. G43-1

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Instruments and controls for power and process

BAILEY METER COMPANY

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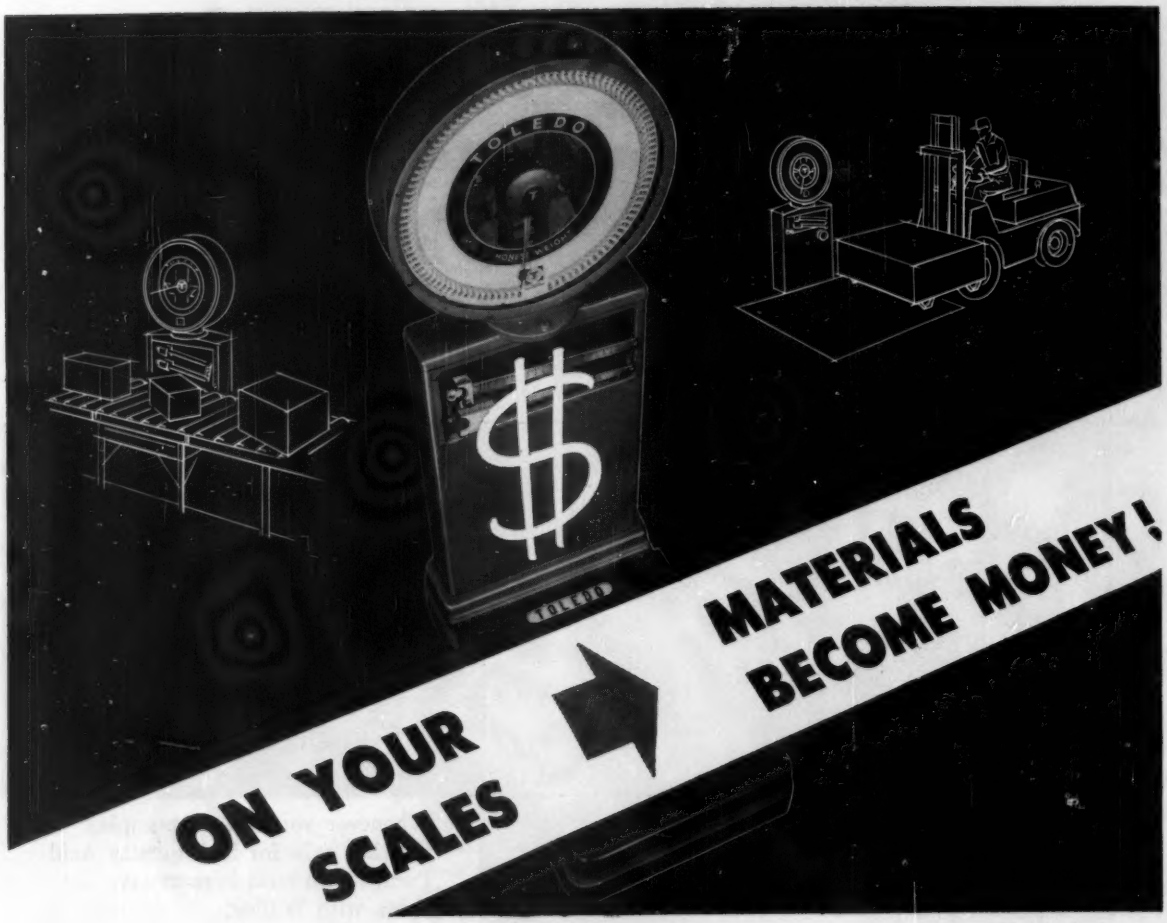
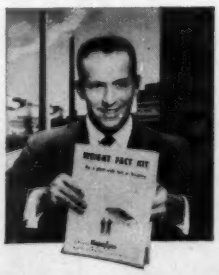


It will pay you to check up on weighing efficiency in your plant!

For proper cost control, efficient weighing is a prime requirement. Weight records directly affect costs, quality, inventory control and customer billing. You can avoid weighing errors and inadequate weight data by placing the right scales in the right places . . . all properly integrated in a *plant-wide weighing system* to supply basic accounting records on materials received, transferred and shipped. You can easily check up on the job your scales are now doing. Just ask for the exclusive Toledo Weight Fact Kit. A Toledoman will gladly explain how it will help you detect and correct weighing inefficiencies in your plant. REQUEST YOUR WEIGHT FACT KIT NOW. No obligation. Address Toledo Scale, 4103 Telegraph Road, Toledo 12, Ohio.



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REMOTE DIGITAL WEIGHT RECORDING


OVERHEAD TRACK SCALES


COUNTING SCALES

in Disc Equipped Bronze Valves

LOOK at that Wheel — Tough malleable iron. Design unequalled for cool, sure grip.

LOOK at the Index Plate — Has Fig. No. etched in green background. Held by wheel nut which is secured by rolled-over spindle end.

LOOK at that Spindle — Made of high tensile bronze. See how much heavier it is . . . how many more deeply cut threads engage bonnet. And, the crowned head that reduces friction on disc holder. Sure, it costs more to make a spindle this way. But it reduces wear, preserves packing, means easier operation.

LOOK at the Packing Nut and Gland—Note the heavy and deep bronze hex. And, that bronze gland designed to compress packing toward spindle.

LOOK at that Packing Box — Its depth equals 1½ times spindle diameter. More packing space means less repacking. An asbestos, lubricated and graphited packing is used.

LOOK at that Bonnet — One-piece, screw-over design with big hex surfaces is easy to remove. Take an extra look at the bevel joint between bonnet and body, serving as an internal brace against the crushing effect of the bonnet assembly. Millions of Fig. 106-A in use for years prove this unique design licks distortion and springing.

LOOK at the Disc Holder — It's the Slip-on Stay-on type originated by Jenkins. Correct protective depth prevents flaking or cracking of disc.

LOOK at the Disc — Easily renewed without removing valve from line. Made of compositions to suit various services . . . and **made by Jenkins**, the only maker of both valves and discs.

LOOK at that Body — Just compare wall thickness of this high tensile bronze body with any other valve. The factor of safety is many times higher than rating requires. See the curved diaphragm to protect seat from distortion by pipe strain. Note that the raised seat is higher to permit more reseating operations . . . and wider, so it won't cut into disc. Pipe threads are full length and clean cut.

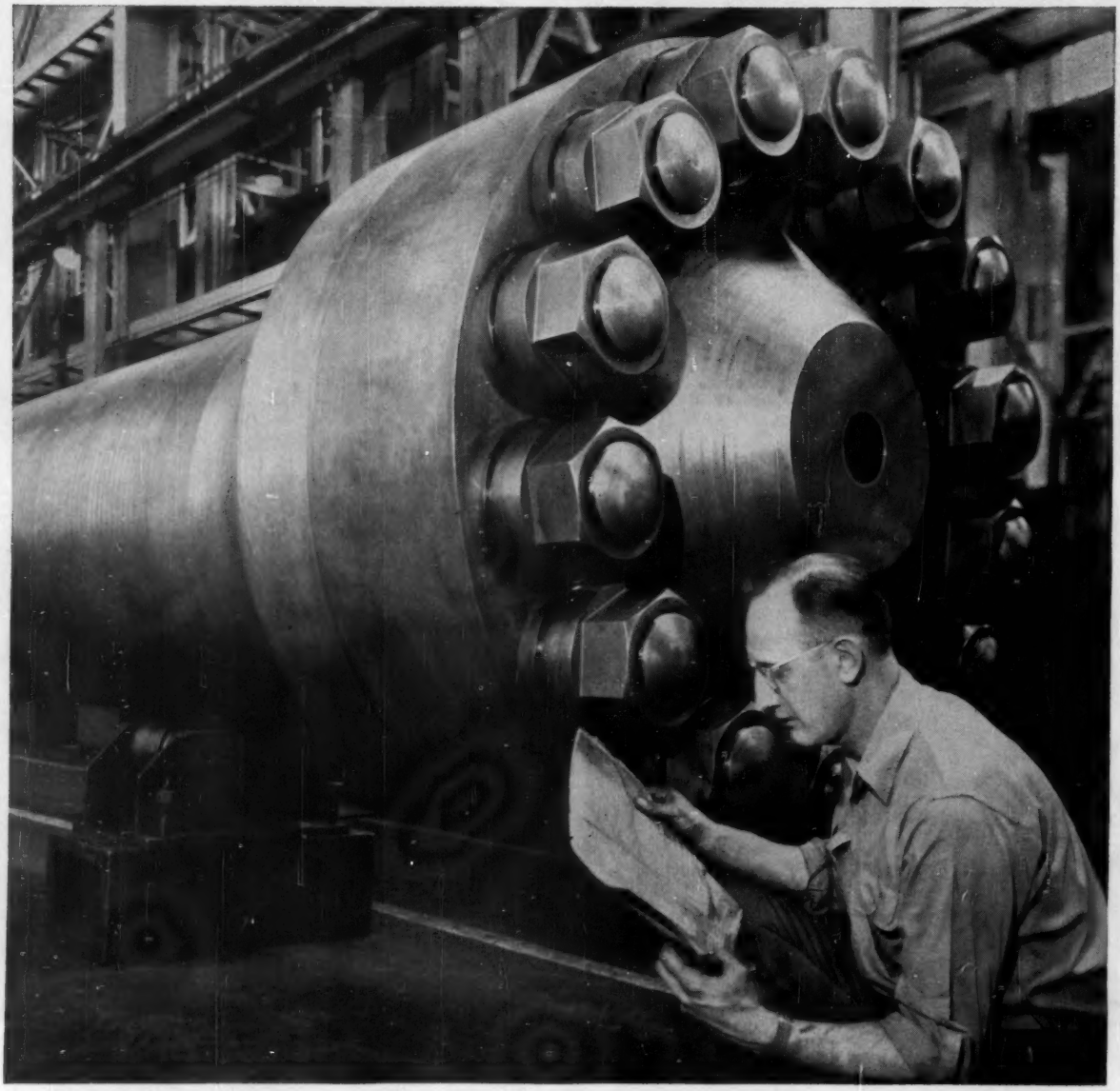
LOOK at this . . . for Throttling

—Just replace the standard disc nut with this Throttling Nut and a Fig. 106-A becomes well-suited to throttling service. This unique nut reduces the effects of wire drawing and its long legs restrict flow for accurate control. Many plants take advantage of this versatile valve to reduce valve and parts inventory.

THE FIRST renewable composition disc valve was a Jenkins Valve, originated nearly a century ago. Compare today's Fig. 106-A Bronze Globe with any other. See why so many valve users agree that a *Jenkins* is still the FIRST for top value. For descriptive folder No. 189-B on the full line of Jenkins Bronze Globe, Angle and Check Valves write to Jenkins Bros., 100 Park Avenue, New York 17.

SOLD THROUGH LEADING DISTRIBUTORS EVERYWHERE

JENKINS VALVES



Strong, Seamless Walls 7½ in. Thick

This forged Bethlehem converter, built for use in the making of ammonia, weighs 48 tons. Much of the weight is in the rugged seamless walls, which are solid steel, 7½ in. thick. Those walls are built to contain high pressures, and they will do the job.

Another interesting feature is the circle of huge nuts that hold the vessel's head to the body. Each of them weighs 77 lb and has a diameter of 10 in. There are 14 nuts and matching studs — convincing evidence of the pressures to be handled.

This could be called a typical Bethlehem vessel of medium weight. Our shops are equipped to build both larger and smaller models of autoclaves, reactors, filters, converters, separators, and high-pressure accumulators. Whatever your needs, Bethlehem can meet them—at competitive prices. Deliveries are prompt. Write for details.

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100% DuPont Nylon Carpet by Barwick Mills. Photo courtesy E. I. DuPont de Nemours & Co. (Inc.)

The Chemical Engineer makes 35,000,000 houses into homes

Synthetic fibers, furniture finishes, nylon upholstery, floor and wall coverings . . . all made possible by the Chemical Engineer and his technology.

The complex chemical process industries produce a multitude of products ranging from paper and plastics to synthetic fibers, rubber and wax. They are tied into a single market . . . buying a third of all manufacturing's capital goods, $46 billion in raw materials and fuels . . . by the critical pres-

ence of the chemical engineer as a common buying-specifying focus. As hundreds of advertisers know, successful CPI selling begins with him.

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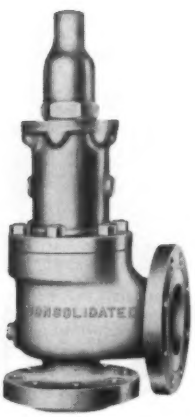
CORRUGATED SLEEVE

shields working parts



Consolidated Safety Relief Valve with Sealing Bellows. Type 1900-30 Series, Sizes: 1½" x 2" to 8" x 10".

A durable, two-ply stainless steel Sealing Bellows in Consolidated Safety Relief Valves isolates contaminants, corrosion or viscous fluids from the working parts. The Bellows is balanced with the seating surface. Capacity is less affected by variable back pressure, so you can use smaller discharge piping and reduce the cost of pressure-relieving systems.

Full-rated relieving capacity is certain at all positions of the single blowdown adjusting ring because a fixed maximum secondary orifice provides full lift at 10% overpressure. Even with superimposed back pressure in the relieving system, valve action is consistently positive.

Protection of working parts is but one of many reasons why Bellows Type Consolidated Safety Relief Valves assure absolute protection for personnel and facilities. Write for details, including facts about the Standard valve that you can convert to the Bellows type in your own shop. Ask for Catalog 1900.

MANNING MAXWELL & MOORE INC. M&M TRADE MARK

CONSOLIDATED SAFETY RELIEF VALVES

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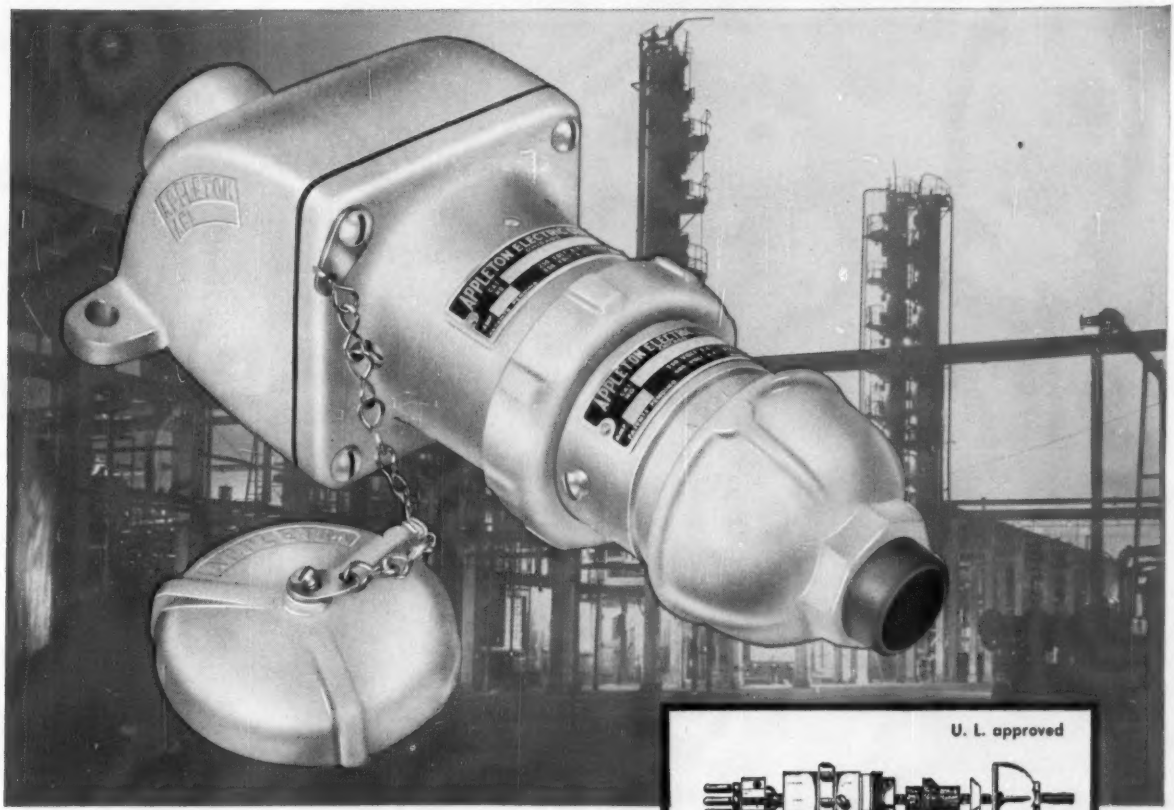
Consolidated Ashcroft Hancock Division • Tulsa, Oklahoma
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

APPLETON® "AE" SERIES

Plugs, Receptacles and Receptacle Fittings



Versatile, Precision Manufactured Plugs and Receptacles for Hundreds of Industrial Applications

The simple, sturdy construction of these APPLETON "AE" Series Plugs, Receptacles and Receptacle Fittings is your assurance of lasting, heavy-duty service.

Complete terminal units, equipped with solderless connectors enable connections to be made quickly with a minimum of effort. APPLETON "AE" Series Receptacle Housings are available in four styles to meet your specific requirements: Lift Cover Housing . . . Plain Housing . . . Threaded Housing . . . and Cap Housing. The Lift Cover Housing has a rubber-gasketed cover mounted on a self-aligning plate to form a dust-resisting enclosure which excludes chips, shavings, etc. Plugs are available with and without Clamping Ring. For utmost versatility and service life, APPLETON "AE" Series Plugs, Receptacles and Receptacle Housings offer an outstanding combination of quality features and economy of purchase.

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APPLETON ELECTRIC COMPANY
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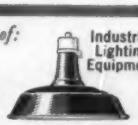
Also Manufacturers of:

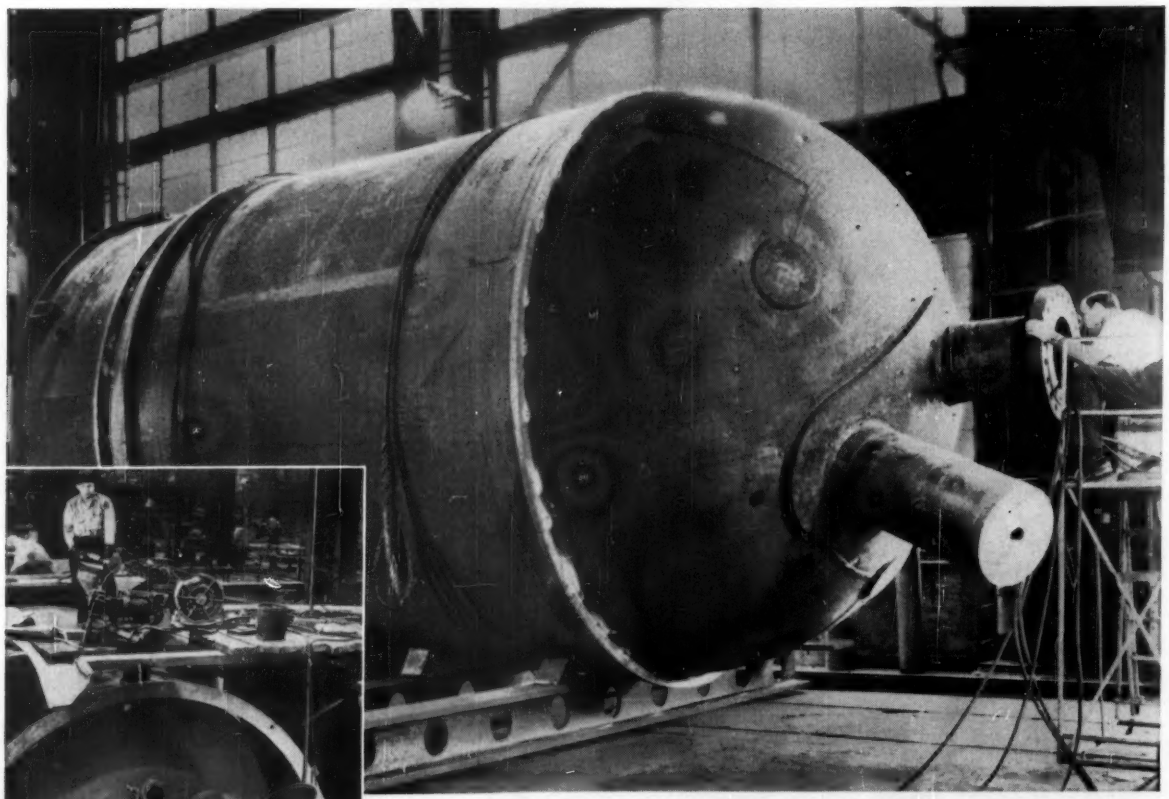

"ST" Series Connectors


Industrial Lighting Equipment


Malleable Iron Unilets

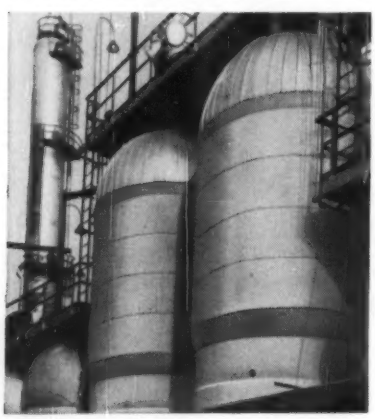

Automatic Reelites

20 ft. long, 12 ft. in diameter, 13 kinds of steel . . . typical of the tough pressure vessel welding jobs Baldwin is noted for



Built by B-L-H's Eddystone Division, a 100-ton pressure vessel made chiefly of chrome molybdenum steel is here shown being inspected by an Eddystone engineer.

Automatic submerged metal arc was one of three welding methods employed on this huge pressure vessel.



Identical vessels fabricated by B-L-H and installed in the catalytic reforming unit of an ultramodern refinery.

A major oil company recently called on Baldwin-Lima-Hamilton's Eddystone Division to weld two identical 100-ton pressure vessels that must operate continuously for long periods of time at nearly 1000°F in a hydrogen-rich atmosphere at pressures up to 536 psi. Baldwin successfully met the challenge of this big job.

Thirteen different kinds of steel ⅜ in. to 5⅛ in. thick and three welding methods—manual-shielded metal arc, automatic submerged metal arc, and inert gas — had to be used on the vessels, each 20 ft. long, 12 ft. in diameter. As on all Baldwin work, only qualified welders were used.

Radiographic inspection of all welds revealed no defects. After the vessels were hydrostatically tested at 1575 psi for 3 hours, all seams were examined for leaks and found to be tight.

For a copy of our illustrated Weldment Bulletin 7001 or for specific information on how we may be of service to you, write to B-L-H Corporation, Philadelphia 42, Pa.

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Eddystone Division

Philadelphia 42, Pa.

Hydraulic turbines • Weldments • Dump cars • Nonferrous castings • Special machinery • Bending rolls • Machine tools

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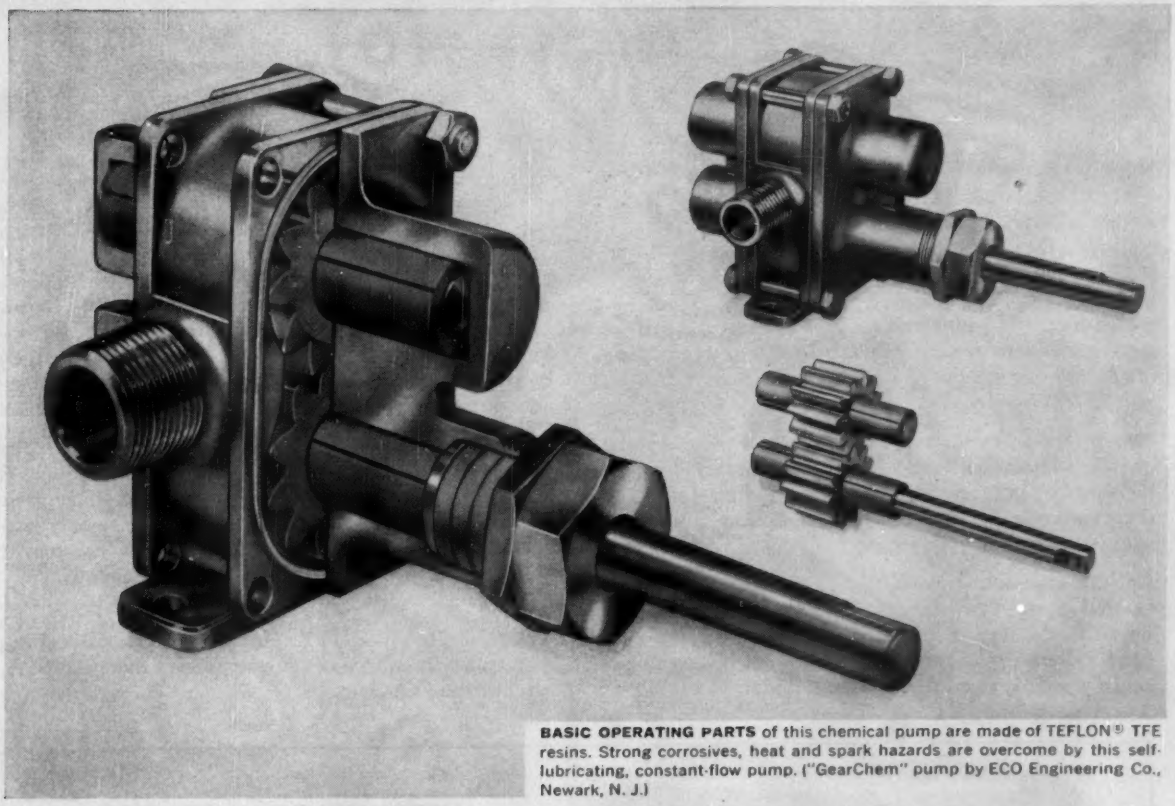
TEFLON®
FLUOROCARBON RESINS

CHEMICAL ENGINEERING NEWS

Gears, bearings and packings of TFE resins create new gear pump for hot, hazardous and corrosive uses



BASIC OPERATING PARTS of this chemical pump are made of TEFLON® TFE resins. Strong corrosives, heat and spark hazards are overcome by this self-lubricating, constant-flow pump. ("GearChem" pump by ECO Engineering Co., Newark, N. J.)

Robust gears of glass-filled TEFLON® TFE resins drive hot, corrosive and hazardous fluids through a new constant-flow metering pump. With rugged bearings of the same material, the pump is entirely "self-lubricating," because of the extremely low coefficient of friction of TFE resins. The gears cannot seize even in non-lubricating media. O-rings of Du Pont TFE resins insure positive sealing of pump faces and gear case.

Since TEFLON TFE resins are rated for continuous use up to 500°F., the temperature rating of the pump far exceeds the 180°F. maximum previously attainable with gear pumps for corrosive services. The new gears eliminate the hazards involved in pumping fluids subject to internal spark and explosive wave propagation typically encountered in missile-grade propellents. With its stainless-steel casing, the pump can handle a great variety of corrosives. The TFE resins themselves are unaffected by the most vicious reagents and solvents known to science. Thanks to the structural and surface properties of TFE resins, the gears show no abrasive wear either on their mating areas or against the gear casing after long periods of operation.

Safety and reliability of equipment can often be increased with components of TEFLON TFE resins. Write for engineering data and examples of how these remarkable Du Pont resins may be applied to improve chemical and petrochemical processes. Address:

E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, Room 77, Du Pont Bldg., Wilmington 98, Delaware.

In Canada: Du Pont Company of Canada (1956) Limited, P.O. Box 660, Montreal, Quebec.

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TEFLON is Du Pont's registered trademark for its fluorocarbon resins, including the TFE (tetrafluoroethylene) resins discussed herein.

NEWS!

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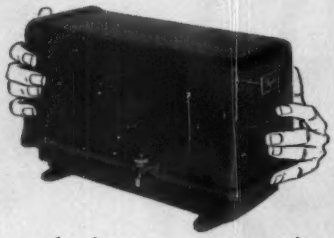
CALIBRATED TO YOUR SPECS.



NOW we can offer you immediate delivery of the 700T Taylor TRANSET* Potentiometer Transmitter—custom-equipped for your specific application. **It's the unique** plug-in features of this instrument—plug-in amplifier, plug-in transducer, plug-in service "cans"—that make it so superior and so readily adaptable to your needs. *And it's these same benefits of flexibility that permit us to fill your orders so promptly.*

Plug-in service "cans" means that the instrument can be quickly adapted for use with different primary elements by simply plugging in the corresponding can. (For thermocouple applications cold junction compensation is provided in the can).

Just one amplifier. You change its service by switching service cans. Both the amplifier and the transducer plug-in . . . means minimum instrument down-time for service. Also means low instrument inventory because you only need one spare amplifier.

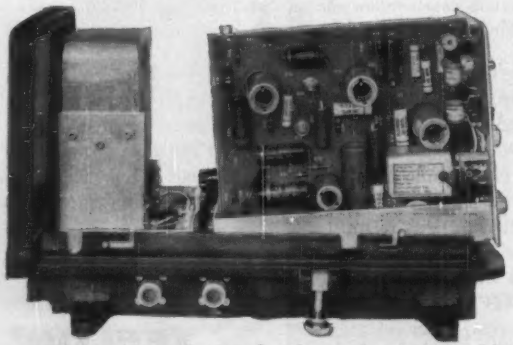
*Reg. U.S. Pat. Off.

Check these additional benefits: • Infinitely sensitive to input signal. • High order of linearity and accuracy. • No moving parts such as slidewires, batteries, or standard cell. • Continuous vernier range adjustment. • Continuous vernier zero or suppression adjustment. • Convenient front panel checkout and adjustment. • Printed circuit, for completely uniform performance. • Thermocouple burnout protection, either up or down scale.

Acknowledged by users as the finest instrument of its kind on the market, the TRANSET Potentiometer is ideal for processes permitting the use of pneumatic receivers and controllers, whether large case or miniature. Its outstanding flexibility permits a narrow or wide range span according to process demands.

• • • •

Call your Taylor Field Engineer, or write for **Catalog 98262.** Taylor Instrument Companies, Rochester, N.Y., or Toronto, Ontario.



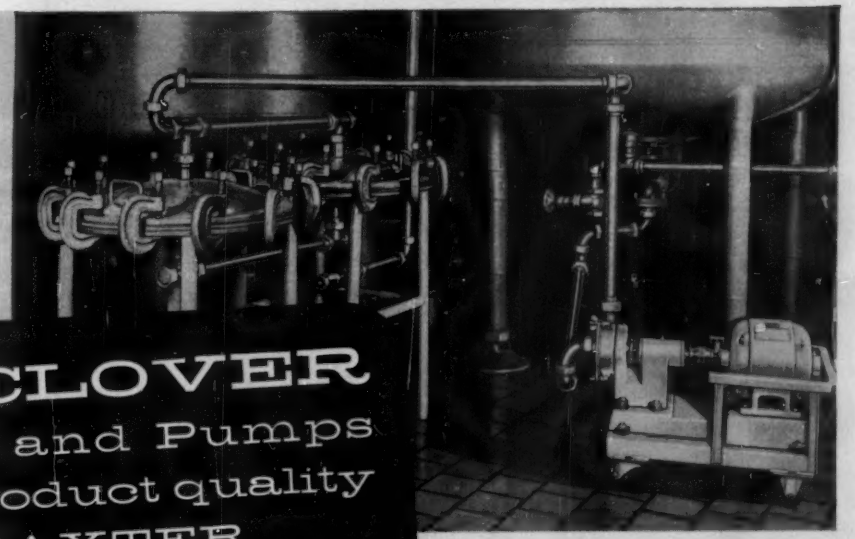
Transmitter converts a dc primary electrical signal into a 3-15 psi pneumatic output for controllers and receivers.

INSTRUMENTS IN STOCK WITH THESE PRIMARY ELEMENTS

THERMOCOUPLE . . . *Copper-Constantan . . . Iron-Constantan . . . Chromel-Alumel*

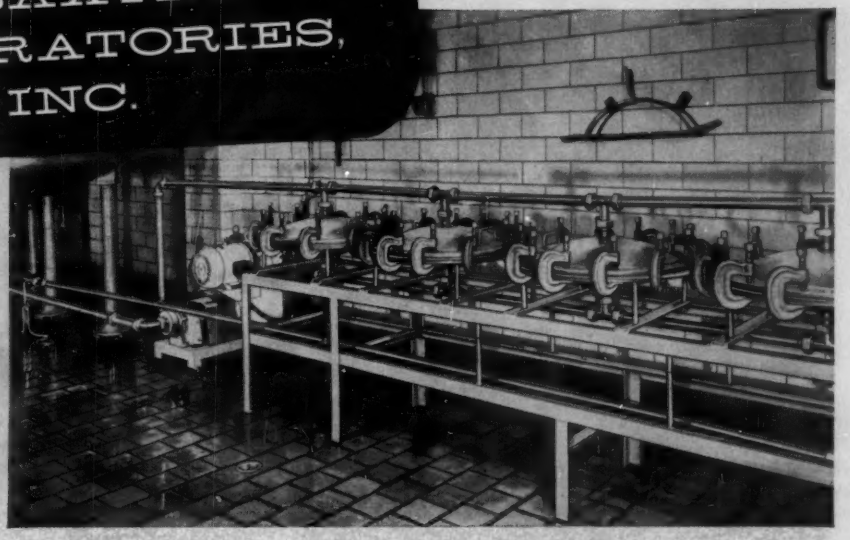
VOLTAGE . . . *For pH; strain gages; tachometers; 0-50 mv.*

Taylor Instruments **MEAN ACCURACY FIRST**



View showing some of the Tri-Clover fittings and one of the transfer pumps being used in the main processing room at Baxter Laboratories.

TRI-CLOVER Fittings and Pumps guard product quality at BAXTER LABORATORIES, INC.



Here is a partial view of the thorough pressure filtration applied to intravenous solutions prior to bottling, in which Tri-Clover fittings and pumps play an important part.

Baxter Laboratories, Inc., has established an enviable reputation in the ethical drug field as the pioneer producers of intravenous solutions to serve the requirements of modern medicine.

Baxter, in its manufacture of medical products, *must* safeguard against all forms of contamination . . . particularly in the preparation of intravenous solutions for infusion into the blood stream.

It is highly significant that Baxter utilizes numerous Tri-Clover Division stainless steel fittings, together with Tri-Clover centrifugal pumps, in their various processing operations, to insure highest standards of product purity and processing efficiency.

For at Baxter Laboratories, as in other important processing operations, users have found that there is no substitute for the high quality and complete sanitation inherent in Tri-Clover products.

Why not let Tri-Clover corrosion-resistant fittings and pumps help to achieve new standards of efficiency and sanitation in *your* processing operations? Our engineering staff will be glad to work with you in helping to solve your specific corrosion-resistant piping and pumping problems.

See your nearest TRI-CLOVER DISTRIBUTOR

1-158

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The expertly crafted enclosure tells you — here's quality. Operating convenience is immediately apparent in the eye-level grouping of controls. Protective interlocks are representative of many safety features. And behind the easy-access doors you'll find engineering, workmanship and components that mean standout performance and dependability. For example, the water-cooled oscillator is built for 5000 hours of service. The heavy-duty plate transformer has a large reserve capacity. Clean wiring arrangements, bakelite standoff, ceramic coils, sturdy relays are just a few more reasons why the Allis-Chalmers dielectric heater is preferred equipment.

2. The manufacturer

When you specifiy Allis-Chalmers, skilled electronic engineers help plan the most efficient use of your dielectric heating. The modern A-C laboratory is at your disposal for material testing. Services include the design of work-handling equipment. Installation is supervised by a trained field engineer. Periodic checkup and emergency maintenance service are also supplied by Allis-Chalmers regional offices conveniently located near you.

See your Allis-Chalmers representative for complete details or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin. Ask for Bulletin 15B6431C.

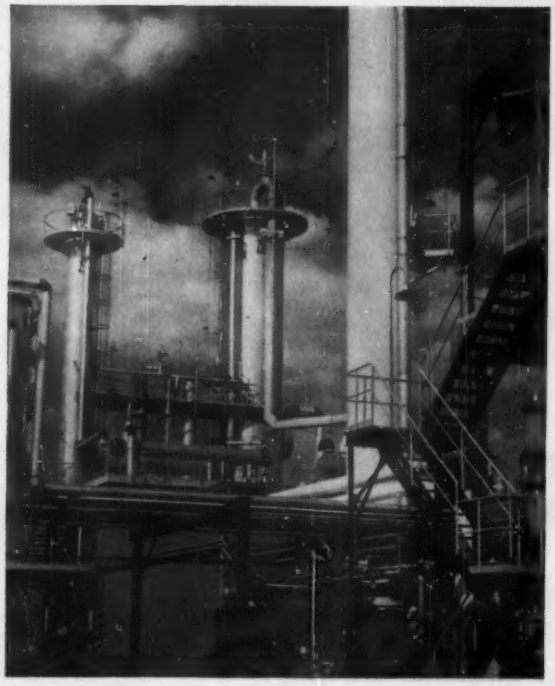
ALLIS-CHALMERS

A-5774

PRACTICE . . .

PROCESS FLOWSHEET

C. H. CHILTON



Big new ethylene oxide plant sticks to air for oxidation despite oxygen-boosters' claim of greater process economies.

GAF Backs Air-Oxidation for Ethylene Oxide

With the startup two months ago of Wyandotte Chemical's ethylene oxide plant at Geismar, La., (*Chem. Eng.*, June 30, p. 60) the battle lines were drawn up in a heated controversy that is sure to simmer for years: Is air-oxidation or oxygen-oxidation the most economical route to ethylene oxide?

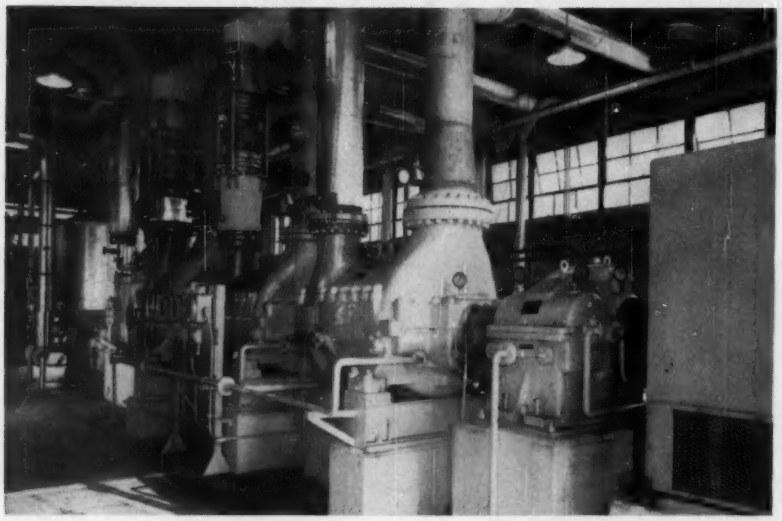
In contrast to Wyandotte's plant, General Aniline & Film's new 60-million-lb./yr. plant at Linden, N. J., is now up to full capacity using air-oxidation and is largest plant yet to come on stream touting air process. Swung on stream last year, the $6-million plant, engineered and built by Scientific Design Co., is the antithesis of the oxygen-oxidation process now being licensed by Shell Development Co.

GAF's plant takes ethylene from Esso's nearby Bayway refinery and air from atmosphere to make an oxide product that is shunted directly into other GAF operations: 24 million lb./yr. go to an adjacent ethylene glycol unit; rest goes into manufacture of synthetic detergents.

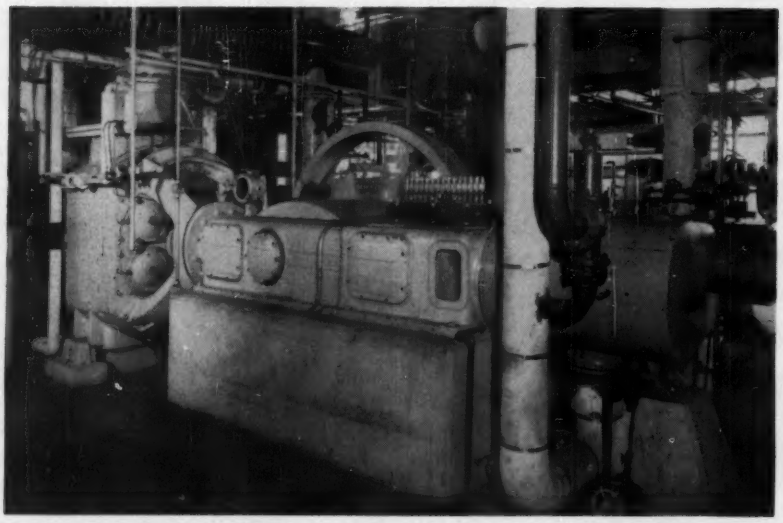
▶ **Both Sides of Coin**—GAF's plant is the fourth and largest of a string of ten SD-designed ethylene plants that will be in production by end of this year. Those in U. S. besides GAF's include Allied Chemical's Orange, Tex., plant (on stream) and Jefferson Chemical's Port Neches, Tex., plant. Six others (two now operating) are located in Europe and one in Japan.

Two other flowsheets are cur-

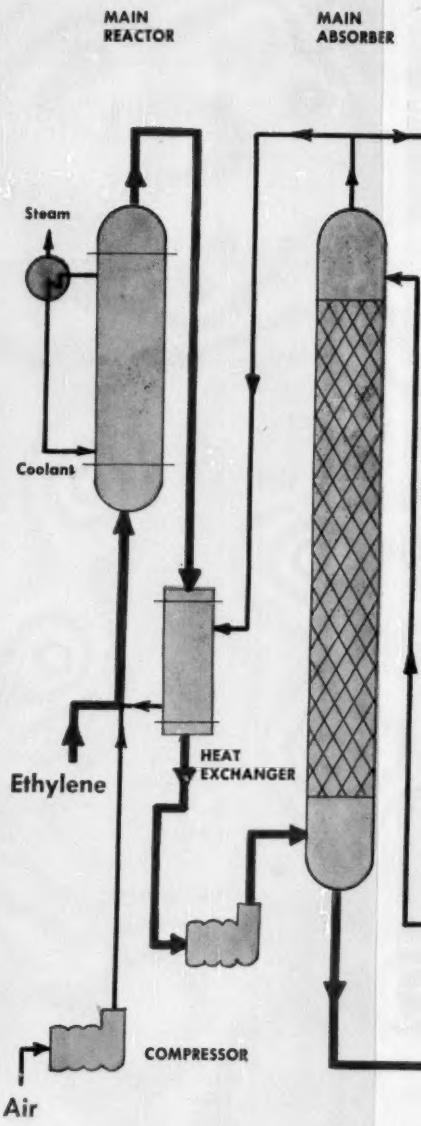
Unfold Flowsheet



AIR COMPRESSOR (three-stage centrifugal) boosts air to 10-20 atm. which is then piped to main reactor for catalytic ethylene oxidation.



ETHYLENE OXIDE COMPRESSOR (two-stage reciprocating) recompresses oxide vapor from desorption column prior to final purification.



rently vying with the SD process for direct-oxidation honors. Shell Development Co., leading proponent of oxygen-oxidation, has its process coming on stream in Calcasieu Chemical's plant at Lake Charles, La., and a Shell plant in Partington, Eng., besides the Wyandotte plant already mentioned. And Union Carbide, pioneer of direct oxidation in this country, uses its own version of direct oxidation process in six out of seven of its ethylene oxide facilities.

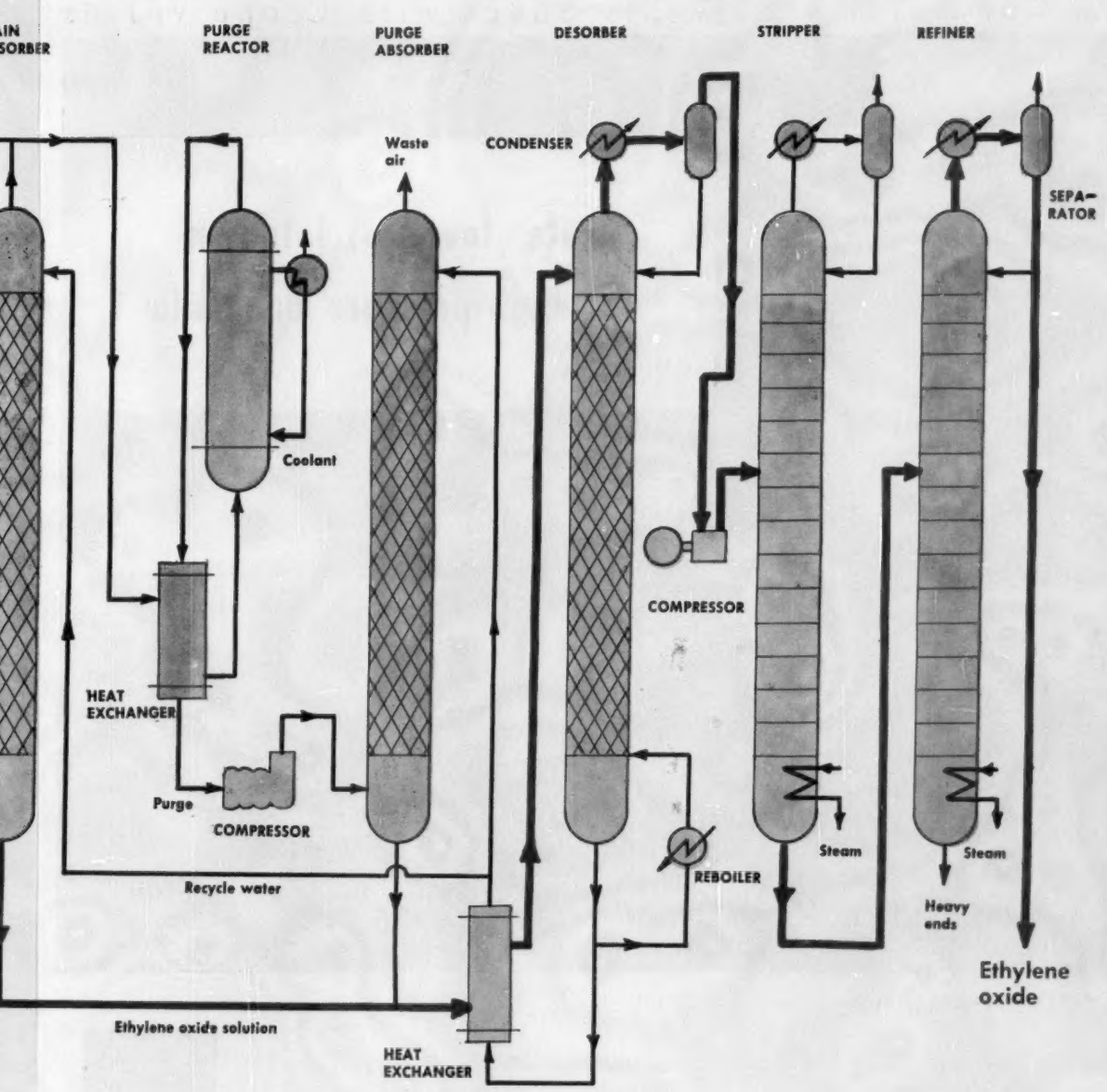
These three direct oxidation processes are combining to relegate the older two-step chlorohydrin route to obsolescence.

▶ **Air or Oxygen?**—Granting the economic superiority of direct oxidation, there remains the question whether air or oxygen is the best oxidizing medium.

Shell argues that by using oxygen, thereby eliminating nitrogen from system, you get lower capital investment and operating costs. Too, says Shell spokesman, absence of nitrogen eliminates need for purging and therefore permits recycle of unreacted ethylene; this results in optimum economic yield.

Scientific Design counters that in order to avoid explosion hazards, oxygen must be diluted with large volumes of inert gas anyway. Furthermore, SD claims, building and operating an oxygen plant is still more expensive than air compression equipment and reactor system in purge stream needed to cut ethylene losses (on which SD controls U. S. patent 2,693,474).

Although GAF's plant could operate on oxygen with only minor operating and equipment changes, the fact that it's engineered pri-



ABSO
reacto

marily for air-oxidation (as are all SD-designed plants) sums up SD's view. Says SD's director of operations, Greg Vinci, "The only time we'd really feel oxygen was worthwhile is if we could get it practically free. Otherwise it jacks up your costs without making any significant contribution to the operation."

▶**Temperature is Critical**—Reactions involved in direct oxidation process are relatively simple:

$C_2H_4 + \frac{1}{2} O_2 \longrightarrow C_2H_4O$

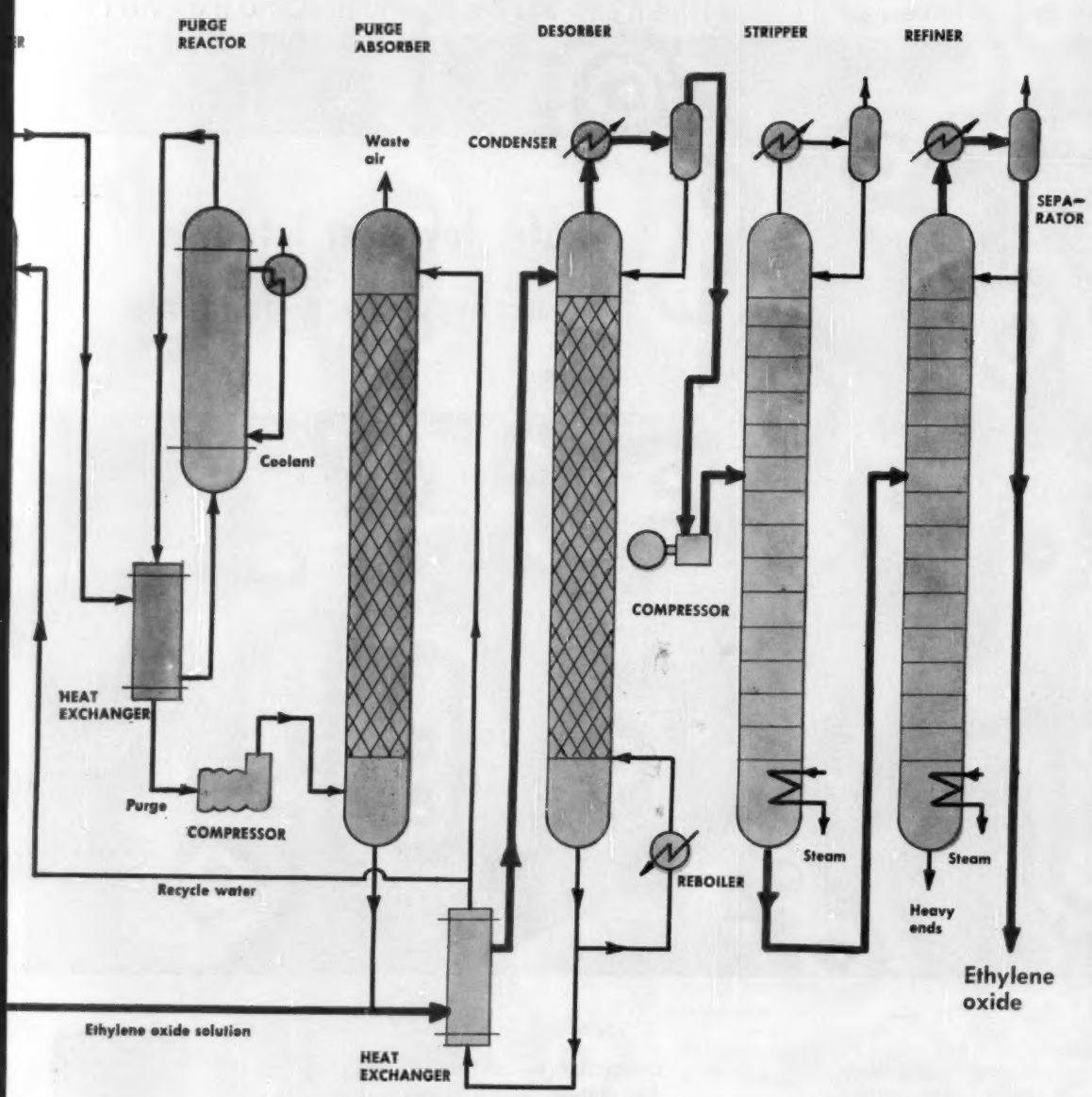
and the side reaction:

$C_2H_4 + 3 O_2 \longrightarrow 2 CO_2 + 2 H_2O$

Key consideration of the oxidation reaction, which is highly exothermic, is temperature control. Consequently, the vertical reactors are essentially shell-and-tube heat exchangers with tubes packed with a rugged, silver-containing catalyst. Mixed ethylene-air stream flows through tubes, while outside the tubes an organic coolant (e.g., Dowtherm) removes reaction heat. Temperature of reaction mixture is held between 450 and 600 F.; pressure ranges from 150 to 300 psi. Coolant circulates through waste-heat boilers, one for each reactor, generating process steam.

Ethylene feed from Esso's nearby Bayway refinery is mixed with air (taken in through a three-stage centrifugal compressor) and fed to the bank of parallel-hooked oxidation reactors exact number is an SD secret.

▶**Next: Absorption**—Gas stream from outlet of each reactor, containing ethylene oxide and unreacted ethylene, is cooled to about 100 F. against recycle stream in a shell-and-tube exchanger. Then all product streams are joined and compressed in a centrifugal blower



ABSORBE
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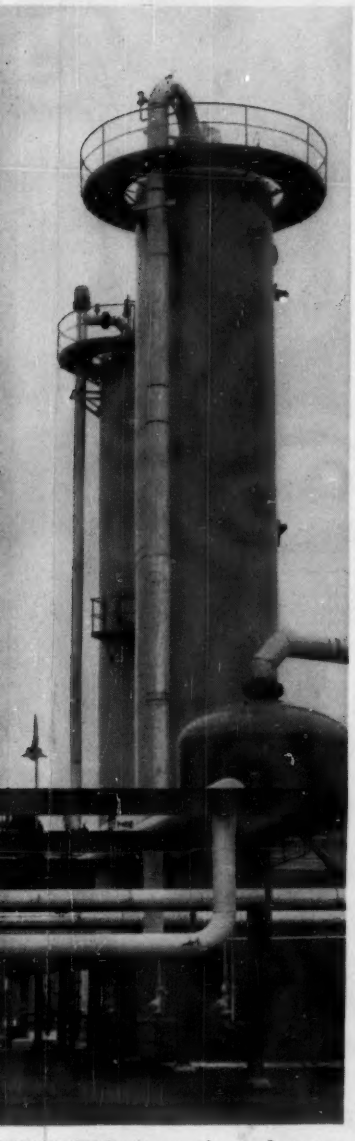
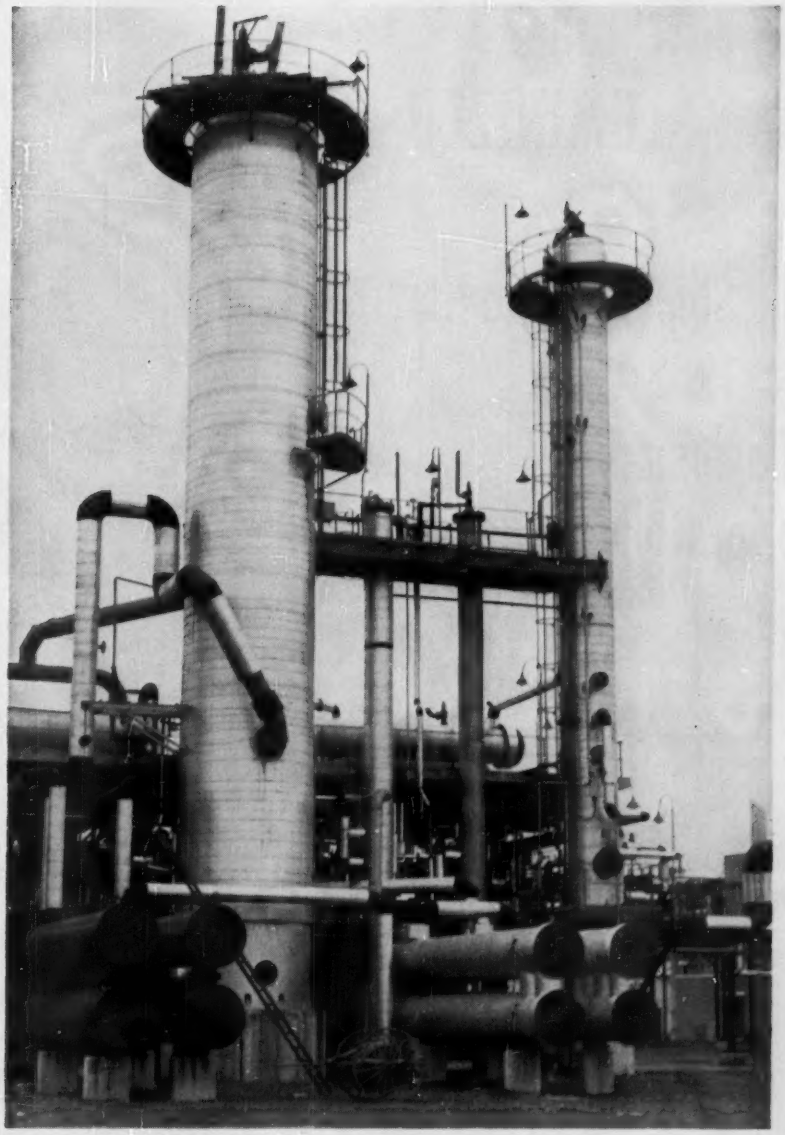


ABSORBERS for main and purge reactors water-absorb oxide vapor



STRIPPER & REFINER (left to right) remove heavy and light ends and deliver ethylene oxide liquid under protective nitrogen blanket.

before entering main absorption tower.

Packed absorber, 60 ft. tall, separates ethylene oxide from nitrogen and unreacted ethylene. Gases pass up the tower against a countercurrent water stream. Ethylene oxide and byproduct carbon dioxide are absorbed in water and pass out the bottom of the tower in solution.

►**Final Purification**—Overhead gas from absorption tower is split into two portions. The larger portion recycles—first as a coolant for reactor effluent, then joins fresh feed being piped to main bank of reactors.

Smaller portion goes to a purge reactor, identical to the primary reactors. Unreacted ethylene is converted to oxide, and product stream from this reactor cools against its own feed stream. Gases then enter a second packed absorption tower, where oxide is again absorbed in a countercurrent water stream. Nitrogen, essentially free of oxide and ethylene, is vented to the atmosphere from top of absorber.

Oxide-containing solutions from both absorbers enter the top of a packed distillation column operating at a slight vacuum. Ethylene oxide is driven off as overhead; bottoms water stream recycles through main and purge absorbers.

Ethylene oxide is then purified by distillation: First compressed in a two-stage compressor, it passes through a two-column fractionating system. Pure liquid oxide (around 99.5%) then goes to storage under a protective nitrogen blanket. Overall process yields normally range from 60% up to 70% in special cases.

New steels are born at Armco

Armco ALUMINIZED STEEL

Stack Shield in Service Since 1953..... No Corrosion, Deterioration or Repairs

Made of Armco's special hot-dip aluminum coated steel, this wind and rain shield was installed in 1953 on a refinery stack. Plant engineers inspected the ALUMINIZED STEEL structure this year and reported—"On inspection in March, the stack shield showed no signs of corrosion or deterioration. No repairs have been made since its installation."

Because of its strength and economical durability, ALUMINIZED STEEL is being used extensively in this plant not only for additional stack shields but also for insulating covers on reactors and other processing units.

TWO TYPES OFFER UNIQUE ADVANTAGES

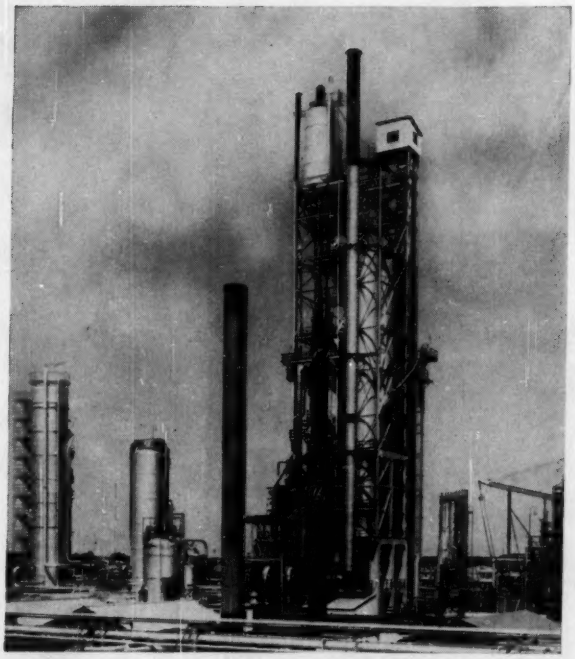
Produced in two grades, Type 1 and Type 2, Armco ALUMINIZED STEEL provides a range of useful properties at low cost that make it ideal for petroleum and chemical plant applications such as shields, insulating covers, jacketing, drying ovens, and buildings.

ALUMINIZED STEEL *Type 1* offers excellent resistance to a combination of heat and corrosion, won't scale at temperatures up to about 1250 F.

ALUMINIZED STEEL *Type 2* has excellent resistance to atmospheric corrosion. Tests show the special aluminum coating lasts at least three times as long as a standard zinc coating on unpainted commercial galvanized steel.

In addition, both types of ALUMINIZED STEEL have good heat reflectivity up to 900 F, plus resistance to fire damage and the strength and rigidity of steel.

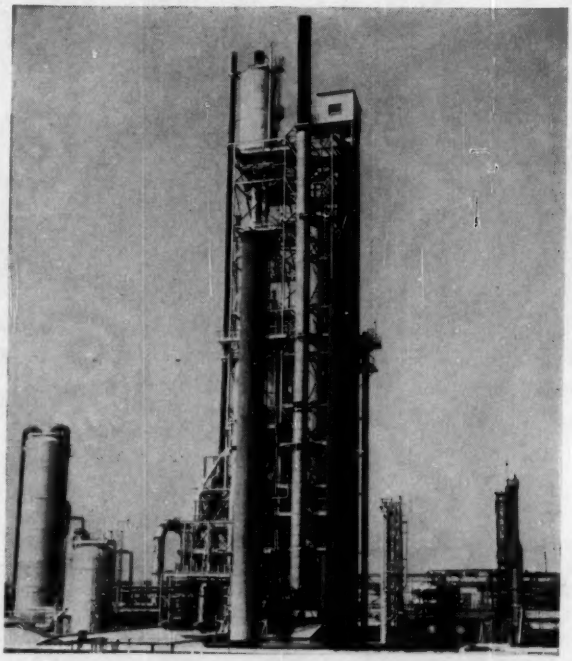
Put the multiple advantages of these hot-dip aluminum coated steels to work in the equipment you make or buy. For complete information on Armco ALUMINIZED STEEL Type 1 or Type 2, write Armco Steel Corporation, 2548 Curtis Street, Middletown, Ohio.



1953

Armco ALUMINIZED STEEL Type 1 shields the stack of a high temperature fractionating column in a Gulf Coast refinery.

1958



ARMCO STEEL

Armco Division • Sheffield Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation • Southwest Steel Products

Chemical Engineering

Practice

JULY 28, 1958

Department Index

HOW TO MAKE AND USE MORE EFFECTIVE *graphs*

GERALD A. LESSELLS
U.S. Industrial Chemicals Co., Cincinnati, Ohio.*

The engineer has at his disposal many ways of presenting data. Tables, graphs and correlation equations with auxiliary explanations in the text are most often used. Of these methods, however, a graph practically always conveys a clearer picture of trends between variables.

Graphs are generally used in three different ways, and the ground rules for drawing graphs vary according to the specific use.

Graph to Indicate a Trend

One major use of graphs is the simple creation of a picture or trend of variables. Possibly in this case only a qualitative relationship is shown. Such qualitative or trend-type graphs present data to people—such as nontechnical salesmen and business managers—who are not working in the highly technical areas of chemical engineering. The audience should always be remembered when graphs are drawn.

Suppose that the sales growth curve for a particular product has to be evaluated and drawn. The curve would be presented to business management and to technical management to bolster recommendations for plant expansion.

We could use a semi-log plot to arrive at the data, but we would replot the curve on rectilinear paper to tell the story at a glance—especially for the benefit of the nontechnical managers.

Such a sales growth curve is shown in Fig. 1 as plotted on rectangular coordinates.

Graph to Correlate Data

Further in this series on graphical presentation we'll go into the subject of rearranging various equations so they can be plotted to make a straight line. For example we know that for any equation of the form $y = ab^x$, y can be plotted against x on semi-log paper to yield a straight line.

*Meet your author on p. 165.

. . . To Show a Trend

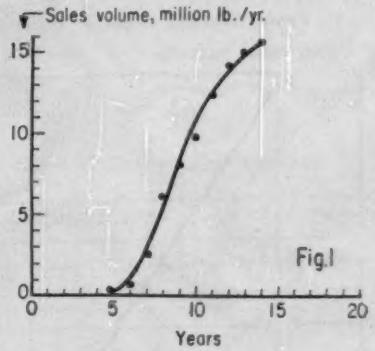


Fig.1

. . . To Correlate Data

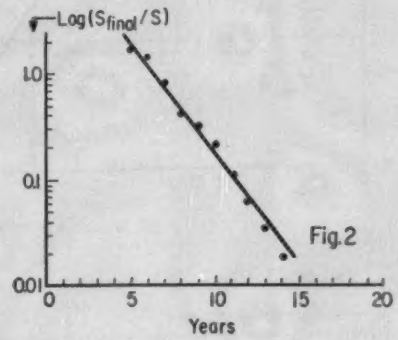


Fig.2

. . . To Confirm a Theory

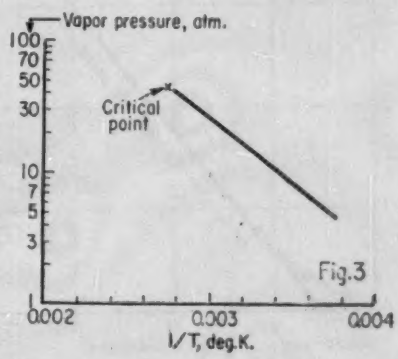


Fig.3

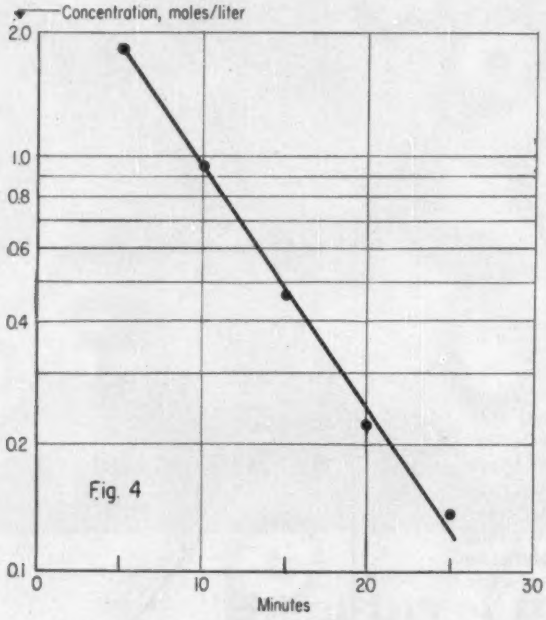
For the sales growth curve the Gompertz equation, $S = ab^z$ where $z = c^t$ and $a = S_{final}$, was used to correlate the data. And log S_{final}/S was plotted vs. time, t, and a straight line results on semi-log paper as shown in Fig. 2.

This straight line correlates the data satisfactorily but presentation of the data in this form would only serve to confuse. It would be logical, however, to use Fig. 2 to get the best correlation line and then to transfer this line onto the curve in Fig. 1.

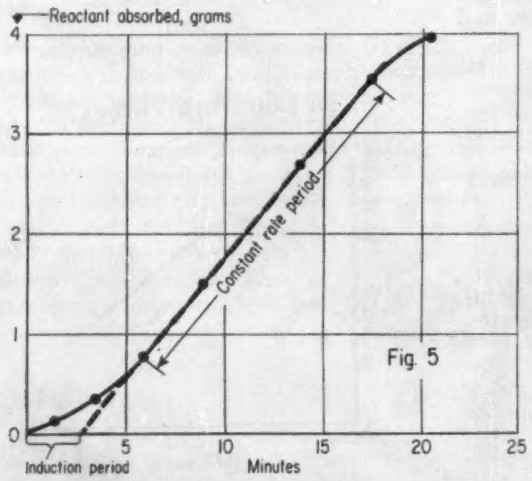
Bar charts and pie diagrams are also useful to show a trend, but seldom are used to correlate data.

Use Graphs

. . . To Prove Reaction Order



. . . To Read Value of Intercept



Graph to Confirm a Theory

The second major area where graphs are employed—and that area most useful to process, research and development engineers—is in the correlation and presentation of experimental data, in the derivation of empirical equations, and as an outgrowth of these, in the provision of design data.

An important corollary use is to "prove" (i.e., indicate) a theory. Quotation marks are used to remind the reader there are certain pitfalls to be avoided in this application.

For example the Clausius-Clapeyron equation has the form: $\log (P_1/P_2) = \Delta H_v[(1/T_2) - (1/T_1)]/2.3\ R$. The equation shows that a plot of log P vs. $(1/T)$ should be a straight line if ΔH_v is constant.

Fig. 3 is a plot of the vapor pressure of propylene vs. reciprocal absolute temperature on 2-cycle semi-log paper. The line is practically straight throughout the whole range, and of course the heat of vaporization should therefore be a constant.

But we know ΔH_v is equal to zero at the critical point, so there must be some anomaly in this "proof" from the graph. The answer lies in the assumptions made in integrating the Clapeyron equation.

These assumptions are (1) ΔH_v is constant, (2) the ideal gas laws hold, and (3) the liquid volume is negligible compared with the vapor volume. These last two assumptions clearly do not hold near the critical point, so a straight line does *not* prove a constant ΔH_v at all points.

However at lower pressures where all the assumptions made in the integration of the equation hold true, a straight line does "prove" or indicate constant ΔH_v. This example shows that fundamental theories should never be bypassed with a total dependence upon graphical technics.

Another important application of graphs in confirming theories is in reaction kinetic studies. By plotting reaction rate data in certain ways we can get straight lines for first-order and second-order reactions.

Here again though a first-order plot does not "prove" a monomolecular reaction. We merely learn from this plot (in the absence of supporting data) that the overall process has characteristics of an apparent or pseudo first-order rate of reaction. Fig. 4 illustrates this type of proof with a semi-log plot of reaction data.

Another variation of the use of graphs to provide empirical equations and to confirm a theory is in obtaining slopes, inflection points, maxima, minima, intersections and intercepts of curves. In the example of the vapor pressure plot of propylene (Fig. 3), ΔH_v is actually calculated from the slope of the line by substituting values of two points on the line into the

Nomenclature

a, b, c	Constants.	P	Pressure.
f	Fractional degree of conversion or heat content.	Q	Heat content.
		R	Gas constant.
		S	Sales volume.
ΔH_v	Heat of vaporization.	t	Time.
k	Reaction rate constant.	T	Absolute temperature.
m	A constant, the slope of a line.	V	Specific volume.
		x, y, z	Variables.

equation relating ΔH_v, vapor pressure, and temperature.

Maxima, minima and inflection points are frequently used to optimize some process: A minimum is sought in a cost curve, a maximum in a yield curve, and an inflection for finding the point of maximum growth rate.

An intercept may give the induction period inherent in a chemical reaction. Fig. 5 illustrates how the induction period of 3 min. is found from reaction or absorption rate data.

Intersections of course determine a point common to two curves, and thus may indicate identical conditions for two processes.

Graph to Solve Equations

The third broad area of graph usage is in the solution of equations. Graphical integration, differentiation and McCabe-Thiele constructions are examples of such use. The derivation of empirical equations or curve fitting might be classified here as well as in the second group discussed above.

In this series we will cover the second area only, since it is felt that the first area is primarily a non- or semitechnical one, while the third part has been covered to a large extent previously.[1]

Rules-of-Thumb and Conventions

Graphical technics are to a great extent an art rather than a science. The conventions governing them are varied and much dependent on who uses the graphs, how they are printed and who benefits from their use. Nevertheless certain basic rules do prevail in the field of graph production, though the rules must be tempered by judgment for each case.

Graphs give a sparkling, live way to present data, and for this reason they should not be inhibited by pedantic regulations which are designed to produce conformity at any cost. The basic guides to follow are those which give a "Yes" answer to:

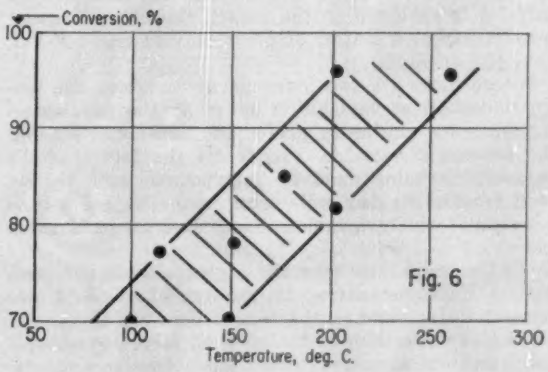
- Is the graph readily understandable by your audience?
- Does the graph say what you want it to say?

Within this framework of reference then, certain conventions have arisen:

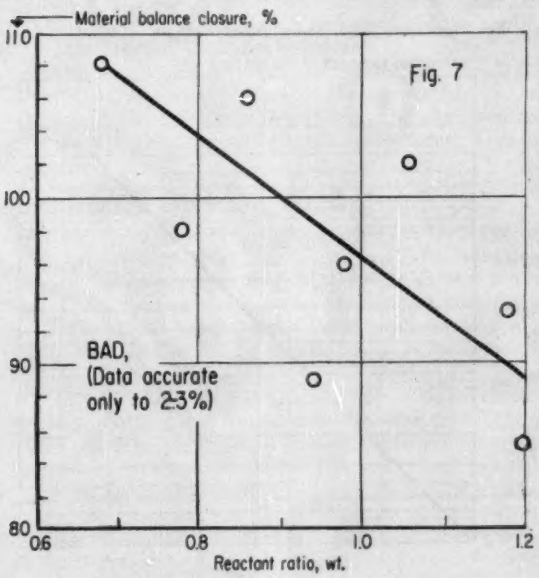
- Label coordinates, title and legend so a complete story can be obtained from the graph with minimal reference to the text.
- Use points or symbols only for actual data. Do not show the arbitrary points used to calculate a line from theory. Such points tend to mislead and imply the existence of experimental data.

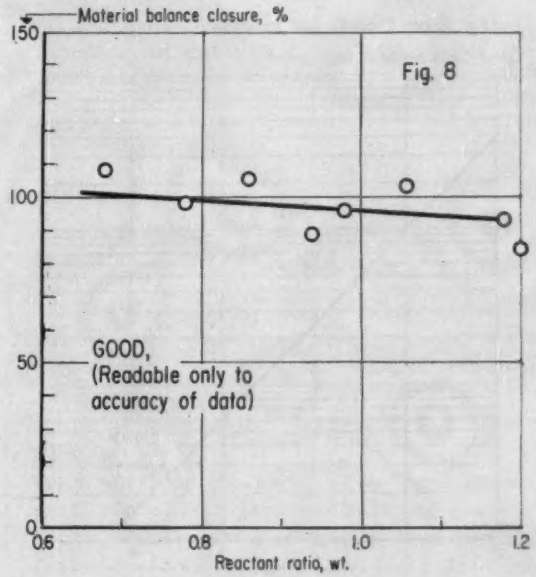
Plot Graphs

. . . To Include Effect of Uncontrolled Variables



Don't Let Scale Give False Impression of Accuracy





• Avoid cluttering the graph with a lot of writing.

• Plot the dependent variable on the ordinate (y-axis) and the independent variable on the abscissa (x-axis).

In some cases exceptions to this convention are quite valid. For example a rotameter scale reading (independent or measured variable) can be plotted on the ordinate and the flow rate (dependent or resulting variable) on the abscissa.

This system is used so that a flowmeter calibration curve may be attached on an instrument panel next to the flowmeter. The eye can then move naturally across from the meter to the ordinate and the curve, and then down to read the flow on the abscissa in one step.

Except for good reasons the independent variable is best plotted on the abscissa for two-variable correlations for the simple reason that engineers have grown accustomed to seeing it there.

In three-variable plots the additional decision of which variable is the dependent one and which one is the parameter must be made. Once the independent variable is assigned to the x-axis, the other decision is arbitrary or a matter of prior convention (a *P-V-T* plot, for example).

Where there are two independent variables, the second independent variable is generally the parameter, though some engineers prefer the parameter's being the dependent variable. Frequently the fact that the parameter's value must be interpolated rather than read from a divided scale such as the x- and y-axes determines which variable is designated the parametric one.

• Use solid lines over the region of data collected, dashed lines for extrapolations or where data are somewhat in doubt.

• In two-variable plots—with no other variables—use line correlations. If other variables are not analyzed but cause data scatter, use an area correlation as shown in Fig. 6.

• The same conventions apply for three-variable plots as for two-variable ones except it may not be possible to use cross-hatched area plots if there is much overlap between the parametric variable ranges—dashed lines through the center of the area can indicate it is not a hard and fast correlation.

• Select data scales so that too high a degree of precision or accuracy is not read from the graph. For example Fig. 7 shows data plotted on an expanded ordinate. The material balance has a 2-3% error in this case so a more realistic and meaningful plot is that in Fig. 8.

• Don't plot graphs with colored lines and data points without first thinking of the potential reproduction, typographical or style problems you might have. The best that can be said for colored graphs is that they are two-edged swords, and pros and cons should be very carefully considered before using them.

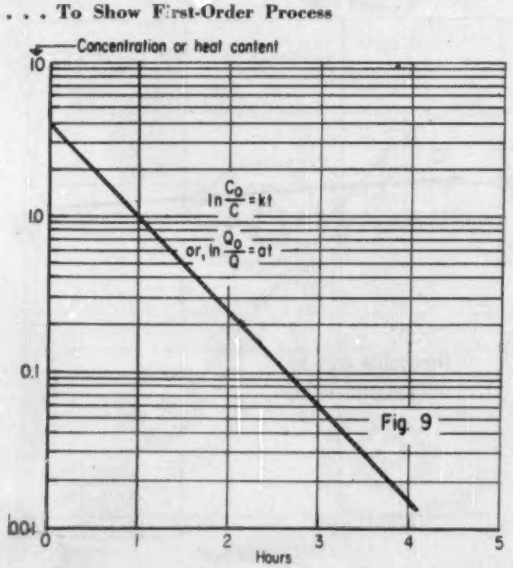
To Be or Not to Be—A Straight Line

Often the best correlation is obtained by plotting data on paper which gives a straight line. If a paper is chosen to get a straight correlation line there is a better chance of drawing the "true" line. For drawing a line there is, after all, only one straightedge. But if a curve must be drawn there are many French and other curves to choose from. Also if it's straight, the precise correlation line can be readily obtained by the least-squares method.

Another advantage of a straight-line plot is the ease of accurate mathematical extrapolation. We must stress that the extrapolation is accurate for the mathematical line, but may not be for the experimental data that's plotted. If a plot on rectilinear coordinates is needed—as shown in the Gompertz curve, Fig. 1—the

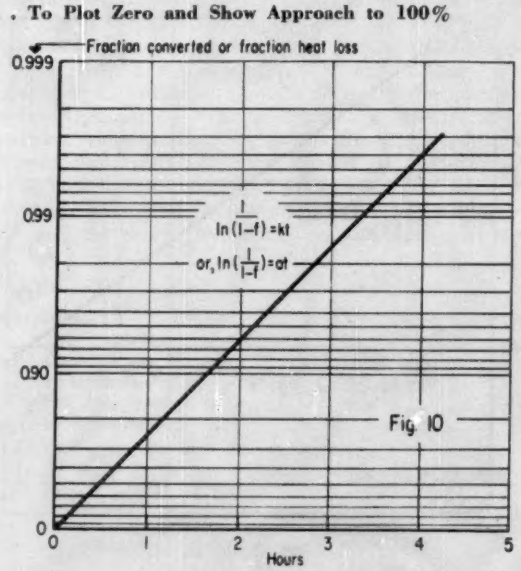
Plot Straight Line on Semi-Log

. . . To Show First-Order Process



Invert Semi-Log Graph

. . . To Plot Zero and Show Approach to 100%



best correlation straight-line plot can be used to back-plot onto other coordinates.

A disadvantage of nonrectilinear coordinates is that interpolation is difficult. This is generally offset by the greater accuracy of the correlation line, however.

Another drawback is that the straight line may not show a trend readily. Engineers traditionally think in a "linear" manner. It takes a while longer to grasp a relationship between variables plotted as a straight line on log-log paper than to get a mental idea about the same data plotted as a curve on linear graph paper. Broadly speaking we should not worship exclusively at the shrine of the straight correlation line, but we should have a good reason for not using it where we can.

Straight Lines on Well-Known Graph Papers

In an earlier CE Refresher[1] the common graph papers—rectangular, semi log, and log-log—were discussed and the basic mathematical equations that plot as straight lines on each of them were given. Here though we will expand this coverage to include some typical chemical engineering equations and trick methods of plotting data to get straight lines and to make the graphs more useful.

Rectilinear or Rectangular—This paper is the workhorse of all graph papers, and is used probably 75% of the time to make plots. Besides being used to plot the straight-line relationship $y = mx + b$, almost without exception rectilinear paper gets the job of showing the data graphically for the first time—just to see what the trend of the data actually is.

The tremendous factor in favor of this paper is that the variables are not distorted on it. Its greatest drawback though is its frequent failure to give a straight line plot.

Semi-Logarithmic or Semi-Log—There is one logarithmic and one linear scale on this paper, and relationships of the form $y = ab^x$ plot as a straight line on it.

The most common application to chemical engineering data is in the integrated form of the equation $(dy/dx) = -ay$, which is $\ln (y_o/y) = ax$. This equation describes a first-order process, and is applicable to kinetics and heat loss problems.

Fig. 9 is a plot of y (concentration of a reactant or heat content) vs. x (time in this case) for the equations shown on the plot. A straight-line plot on semi-log paper is always an indicator of an apparent first-order process.

Sometimes it is desirable to plot the fraction of reactant converted or the fraction of heat lost versus the time. An algebraic manipulation converts (y_o/y) to $1/(1\text{-}f)$, where $f = (y_o - y)/y_o$. The equation $\ln (y_o/y) = ax$ becomes $\ln 1/(1\text{-}f) = ax$ so that a plot of $(1\text{-}f)$ vs. x on semi-log paper results in a straight line.

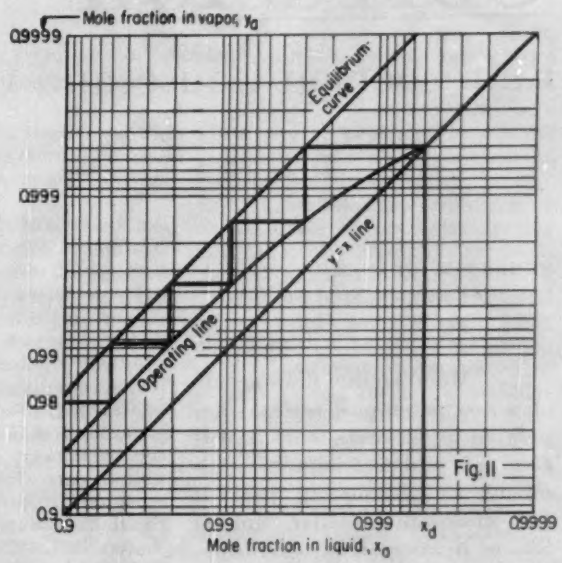
However, if the log scale is inverted, the log coordinate may be labeled in units of f directly rather than $(1\text{-}f)$ as shown in Fig. 10.

This techinque is not generally used, but it definitely makes plotting and reading easier. The trick also gets zero on the paper and provides order-of-magnitude approach to the final value (100% in these examples).

Data from first-order processes should be plotted as straight lines on semi-log plots and the slope of the line used to calculate the constant a in the integrated rate expression.

Invert Log-Log Graph Paper

. . . To Plot Data in More Useful Terms



Logarithmic or Log-Log—This paper has both ordinate and abscissa graduated logarithmically, and the equation $y = ax^m$ plots as a straight line on it. Besides the advantage of getting a straight line for such a complicated expression, several orders of magnitude may be plotted on each axis on one graph.

Should we wish to plot a linear expression covering several orders of magnitude with accuracy in each order, we must accept a curve instead of a straight line. Horvath and Schubert[3] use this technique in plotting a McCabe-Thiele diagram as shown in Fig. 11. Their equilibrium lines are straight, but the operating lines are curved since they represent linear expressions.

These authors also used the little-known technique of inverting the logarithmic axes as discussed above for semi-log plots and illustrated in Fig. 10. In this manner the mole fractions could be plotted directly though the actual scales represent (1 − mole fraction) on the original log paper.

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Coming

You'll learn next about some of the more esoteric graph papers. We'll show you tricks and give you tips to broaden your graphiological know-how.

Corrosion

Refresher on Cause and Cure

ROBERT V. JELINEK,
Syracuse University, Syracuse, N. Y.*

Here is the first article of a new seven-part series. Appearing in alternate issues it will give you practical help in minimizing or eliminating part of the multi-billion-dollar annual loss to industry from corrosion.

As a threat to plant equipment, personal safety and product purity, corrosion is a matter of vital concern to every chemical engineer. Economically we can regard corrosion as a tax.

Precise evaluation of this corrosion tax is virtually impossible, since indirect losses represent a major incalculable part of the total. Several years ago, Uhlig[6] made a careful survey of only the direct losses by corrosion in the United States and reported a staggering rate in excess of $5.5 billion annually. Included in this sum are the replacement and maintenance of corroded equipment and the costs of painting, electroplating and other protective measures including application and labor costs.

In the nine year interval since this study was published, corrosion control methods have been improved considerably. However, material and labor costs have generally risen. Thus the order of magnitude of the direct costs[7] of corrosion remains about the same. For 1956, Nelson[8] estimates that corrosion cost petroleum refiners about $560 million.

Among indirect costs must be counted loss of life, physical injuries, psychological effects relating to unpredictable explosion or equipment failure and other factors which are impossible to express in terms of monetary value.

Loss of oil, natural gas and water through corroded pipes; product contamination through leaks; spoiling of food in metal containers; production losses during shutdown for repairs—these too are all very real losses chargeable to corrosion. These losses are necessarily termed indirect because they can not even be estimated.

Corrosion often forces the design engineer to apply an uncertainty factor where corrosion rates are unknown. Hence, many tons of metal are wasted each year through equipment over-design. Examples of over-design are found in the construction of reaction vessels, boiler and condenser tubes, underground pipelines, water tanks and marine structures.

We can easily cite many examples where substantial savings are possible through better corrosion control. In one case,[8] an improvement in corrosion protection permitting a 20% reduction in wall-thickness of an 8-in. pipeline saved about 16 tons of steel per mile and upped line capacity 5%.

Even this brief discussion of cost makes it obvious that strong economic incentives exist for investment in corrosion research. More extensive application of control methods already known should yield substantial dividends. An improvement of only 1% in decreased corrosion means an annual saving of at least $5.5 million.

Corrosion is of special interest to the chemical engineer, since he encounters it as a major factor in most chemical processes. Also, he is often called upon to solve corrosion problems in other industries as well.

Fortunately, the basic principles of physical chemistry and mass transfer operations in which the modern chemical engineer is well-grounded serve him very well in attacking corrosion problems. Systematic application of these principles in recent years has made possible explanation of previously mysterious corrosion phenomena and enabled the development of present day corrosion control techniques.

How Corrosion Occurs

Corrosion processes involving metals can best be classified into two types: oxidative and non-oxidative. The former is by far the more common type since it includes both ordinary atmospheric corrosion and chemical attack by acids and corrosive gases.

In oxidative corrosion, the metal undergoes chemical oxidation, losing electrons and increasing in positive valence—essentially reverting to its ore. The laws of nature, of course, require that another substance—usually the environment or corroding agent—be simultaneously reduced.

It has been firmly established that at ordinary temperatures, this oxidation-reduction takes place by an electrochemical mechanism[1,2,4] through the formation of spontaneous galvanic cells in the presence of moisture. Only at rather high temperatures (about 1,500 F. for iron in oxygen) will dry gases directly attack and oxidize most metals in their usual structural forms.

Proper application of the proven principles of electrochemistry makes possible the understanding and control of the various phenomena peculiar to galvanic corrosion. In order for galvanic corrosion to proceed, separate anodic and cathodic areas must exist on a metal surface and an electrical potential difference between them to provide the driving force. Moisture must be present to form an electrolyte. The circuit is com-

* To meet your author, see p. 161.

pleted by flow of electrons through the metal from anodic to cathodic areas.

At the anodes, metal is oxidized and metallic ions enter into solution. At the cathodes, the corroding agent is reduced. The rate of corrosion is influenced by a number of modifying factors such as light, heat, surface homogeneity and the presence or absence of natural or artificial polarizers.

Variations in these factors produce different patterns of attack which Fontanna[9] classifies under eight general categories:

- Uniform corrosion.
- Pitting.
- Bi-metallic corrosion.
- Concentration cell corrosion.
- Intergranular corrosion.
- Stress corrosion.
- Dezincification.
- Erosion-corrosion.

Uniform corrosion is the most common type of attack and accounts for most of the annual losses of metal on a weight basis. It is also the least intense in its action and is relatively easy to predict and control.

The other more localized and intense forms of attack often cause more serious failures. Their outward characteristics are quite varied. A major achievement of modern corrosion research has been to show that all of these forms of corrosion are really variations of the same basic electrochemical principles.

The modifying effects of erosion should always be considered in any study of corrosion problems. Erosion denotes a process of mechanical wear or abrasion in contrast to the chemical or solution processes defined as corrosion.

Erosion often accelerates or intensifies corrosion by removing protective films or deposits of corrosion products, thereby exposing new surfaces to attack. Such effects are particularly important in corrosion by flowing liquids and in applications where metal parts rotate in a corrosive medium.

The chemical engineer encounters many cases of erosion-corrosion failure in valves, elbows, agitators, pumps and heat exchangers. Cavitation which is commonly found on the trailing edges of propellers and impellers is regarded as an extreme form of the erosion-corrosion type of attack.

Preview of Corrosion Refresher

In this issue and alternate following issues, you'll find basic concepts on how to analyze your corrosion problems.

1 Introduction to the series. This issue: why you should be interested in corrosion, how it occurs.

2 Oxidative corrosion has electrochemical basis. First, we review the chemistry of galvanic cells. Then we review the methods of calculating the effects of concentration and temperature on cell potentials. Finally, we apply these principles to corrosion cells and extend the discussion to cover special types of oxidative corrosion.

3 For corrosion control, try modification of environment. Environment modification, often the simplest immediate means of retarding corrosion, includes temperature and pH control, deaeration, use of inhibitors and cathodic protection.

4 For corrosion control, use resistant materials and protective coatings. Here, we consider the use of more resistant materials and protective coatings to minimize or eliminate corrosion. Also given are practical criteria for material selection and a guide to some of the literature in this area.

5 For corrosion control, use proper design and fabrication of equipment. In this article, we'll point out how the design engineer can avoid common and costly pitfalls in equipment design by observing simple rules based on actual corrosion principles.

6 Non-oxidative corrosion. Non-oxidative corrosion occurs in handling liquid metals[8] and presents serious problems because it is not yet as well understood as the chemical type.

In non-oxidative corrosion, a metal dissolves or distintegrates but is not chemically oxidized. Typical examples are solution of a metal or diffusion of liquid metal into a solid metal lattice. Alloy disintegration by chemical attack on a minor constituent may also be considered a form of non-oxidative attack on the bulk metal. This phenomenon is common in corrosion by liquid metals.

Development of nuclear reactors circulating molten metals such as sodium, potassium and bismuth through metal vessels and piping presents new and serious corrosion problems. Much current research in this area is still encyclopedic in nature.

Correlation and interpretation of these data present excellent opportunities for the chemical engineer to apply his training and experience in mass transfer operations.

7 How to apply field and service methods in corrosion testing. In the final installment, we review modern methods of corrosion testing. A number of standard procedures are in common use, but the corrosion engineer must often devise field and service tests. These test require familiarity with corrosion fundamentals as well as intelligent application of data analysis and correlation.

We'll evaluate these new testing techniques so that the chemical engineer can apply them to the art of corrosion control.

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Major Cost Analysis Methods Yield

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IF YOU'VE been wondering which of the "exact" methods to use for an engineering cost comparison—don't worry. They're all equivalent.

If you're using one of the "exact" methods maybe you're bothered about the enthusiasm shown for other "exact" methods. Don't worry—your particular method is giving the right answer.

In the past, there've been several inferences that two methods can give different numerical results. In every case the differences came from improper understanding of the problem and a misuse of the figures.

Properly and consistently used, any of the "exact" methods give equivalent results. If an allowance is made for interest or rate of return on all items involved in the calculation, a method is "exact."

Fundamentally, all the methods are present worth methods. This explains why they should and do give equivalent comparisons. They are:

- Present worth
- Rate of return
- Annual cost
- Capitalized cost

Present worth,[1] since it's the basis of all four methods, is always applicable. Rate of return,[1] is also called discounted cash flow,[2] investor's method[3] and profitability index.[4] It's most useful with an entire venture where costs over a period of years are compared with receipts over the same period of years.

Present worth and rate of return methods aren't convenient for comparing articles or systems with different service lives. You've got to make the comparison for some period of time that's a common denominator of the service lives.

Annual cost[1] and capitalized cost methods[5] have built-in factors that allow for differences in service lives. Annual cost uses unity as a common denominator for all service lives; capitalized cost uses infinity as a common denominator.

For some problems certain methods may be more convenient than others, but all can be used. For example, present worth can be used in a problem involving different service lives by incorporating a common denominator of the service lives in the solution.

Conversely, annual cost and capitalized cost can be used in problems involving comparisons for identical service lives. In such cases the built in factors that adjust for different service lives aren't necessary but they're still not detrimental.

A few numerical examples demonstrate the equivalency of all the methods. For consistency, costs are positive and receipts negative. Uniform yearly expenses, though occuring during the year, are given as a single equivalent expense as of the end of the year.

*Meet your author on page 160.

When Discussing Equipment Choice . . .

Problem: Which machine, A or B, is more economical? Money is worth 8% per year and costs and service lives are as follows:

	A	*B*
First cost, $	9,696	25,000
Salvage value, $	500	1,500
Uniform end-of-year expense, $/year	3,000	2,000
Service life, years	2	5

Solution by present worth requires only the repeated use of one basic relationship:

$$(PW) = (FW)/(1 + i)^m \qquad (1)$$

This gives the present worth, PW, of a future worth, FW, occurring exactly m years from now, where i is the decimal interest rate or rate of return.

Comparison will be made on a 10-year basis as it's the lowest common denominator of time. At the end of 10 years we're in a position to purchase a new machine whether we started out with A or B, and replaced in kind.

Present worth of 10 years of service for A is:

$$(PW)_A = \frac{9,696}{(1.08)^0} + \frac{9,196}{(1.08)^2} + \frac{9,196}{(1.08)^4} + \frac{9,196}{(1.08)^6} + \frac{9,196}{(1.08)^8} - \frac{500}{(1.08)^{10}} + \sum_{x=1}^{x=10} \frac{3,000}{(1.08)^x}$$

$(PW)_A$ = $55,000

Present worth of 10 years of service for B is:

$$(PW)_B = \frac{25,000}{(1.08)^0} + \frac{23,500}{(1.08)^5} - \frac{1,500}{(1.08)^{10}} + \sum_{x=1}^{x=10} \frac{2,000}{(1.08)^x}$$

$(PW)_B$ = $53,719

Machine B is more economical. Present worth of $53,719 for 10 years of service against $55,000 for machine A.

Ratio of present worths is:

$(PW)_A/(PW)_B = 55,000/53,719 = 1.0238$

Solution by rate of return method compares receipts against expenses. In this particular problem we don't know the receipts. Assume the machines perform the same service. Then, receipts are the same for both machines and don't enter the comparison.

Equivalent Answers

Major methods of making cost analyses may not be equally convenient to use but they all give equivalent results.

We'll use the rate of return method by looking at the problem this way:

Suppose we buy machine A. Then, we save all costs associated with B and regard them as receipts. We'll make the comparison on a 10-year basis in order to have a common denominator. Present worth of buying A and avoiding buying B is:

$$(PW) = \left[\frac{9{,}696}{(1+i)^0} + \frac{9{,}196}{(1+i)^2} + \frac{9{,}196}{(1+i)^4} + \frac{9{,}196}{(1+i)^6} + \frac{9{,}196}{(1+i)^8} - \frac{500}{(1+i)^{10}} + \sum_{x=1}^{x=10} \frac{3{,}000}{(1+i)^x}\right] - \left[\frac{25{,}000}{(1+i)^0} + \frac{23{,}500}{(1+i)^5} - \frac{1{,}500}{(1+i)^{10}} + \sum_{x=1}^{x=10} \frac{3{,}000}{(1+i)^x}\right]$$

This method normally is used with the result in terms of i; but here i is given as 0.08. Placing this value for i in the above equation gives:

$(PW) = (55{,}000) - (53{,}719) = +1{,}281$

Result is positive, a net expense. Machine B should be bought to avoid the expenses associated with A.

Ratio of costs is clearly evident:

$A/B = 55{,}000/53{,}719 = 1.0238$

Solution by annual cost can be computed directly.[1]

$$k = (C - L)\left[\frac{i\,(1+i)^m}{(1+i)^m - 1}\right] + L\,i + M' \qquad (2)$$

From Eq. (2), the annual cost is:

$$k_A = (9{,}696 - 500)\left[\frac{(0.08)\ (1.08)^2}{(1.08)^2 - 1}\right] + (500)\ (0.08) + (3{,}000)\ (0.08)$$

$k_A = \$8{,}197$

$$k_B = (25{,}000 - 1{,}500)\left[\frac{(0.08)\ (1.08)^5}{(1.08)^5 - 1}\right] + (1{,}500)\ (0.08) + (2{,}000)$$

$k_B = \$8{,}006$

Machine B is more economical. Ratio of annual cost is:

$k_A/k_B = 8{,}197/8{,}006 = 1.0238$

Solution by the capitalized cost method requires the following relationships[2] **for the capitalized cost K.**

$$K = C\left[\frac{(1+i)^m}{(1+i)^m - 1}\right] \qquad (3)$$

$$K = -L\left[\frac{1}{(1+i)^m - 1}\right] \qquad (4)$$

$$K = M'/i \qquad (5)$$

Here, M' refers to the end of the year so Eq. (5) is slightly different from the one given in the reference.

Above relationships give for capitalized cost of machine A:

$$(9{,}696)\left[\frac{(1.08)^2}{(1.08)^2 - 1}\right] = 67{,}969$$

$$-(500)\left[\frac{1}{(1.08)^2 - 1}\right] = -3{,}005$$

$$(3{,}000)/(0.08) = 37{,}500$$

$$K_A = \$102{,}464$$

For machine B:

$$(25{,}000)\left[\frac{(1.08)^5}{(1.08)^5 - 1}\right] = 78{,}275$$

$$-(1{,}500)\left[\frac{1}{(1.08)^5 - 1}\right] = -3{,}197$$

$$(2{,}000)/(0.08) = 25{,}000$$

$$K_B = \$100{,}078$$

Machine B is more economical. Ratio of capitalized costs is:

$K_A/K_B = 102{,}464/100{,}078 = 1.0238$

. . . Or Finding Return on Investment

Problem: What is the rate of return on a project that requires an expenditure of $1,000,000 now and will be abandoned with a salvage value of $38,000 at the end of three years? Net income (receipts less expenses before depreciation) for the first year will be $500,000, referred to the end of the year; for the second year $600,000; and for the third year $250,000.

This example is typical of a type that's used to illustrate the rate of return method. We only wish to show here that it can be analyzed by any of the methods.

Solution by present worth or rate of return requires a knowledge of present worth of all amounts involved:

$$(PW) = \left[\frac{1{,}000{,}000}{(1+i)^0}\right] - \left[\frac{500{,}000}{(1+i)^1}\right] - \left[\frac{600{,}000}{(1+i)^2}\right] - \left[\frac{250{,}000 + 38{,}000}{(1+i)^3}\right]$$

If receipts and expenditures are equal on a present worth basis then (PW) in the above equation is zero. Value of i that makes $(PW) = 0$ must be found by trial and is $i = 0.20$.

Project will return 20% on the investment.

Solution by annual cost method is accomplished by repeated use of a single annual cost relationship.

If an article or system last m years and incurs and end-of-year expense B_x' at the end of the xth year, annual cost of this single yearly expense is:

$$k = \left[\frac{B_x'}{(1+i)^x}\right]\left[\frac{i(1+i)^m}{(1+i)^m - 1}\right] \qquad (6)$$

Repeated use of Eq. (6) gives:

$$k = \left[\frac{1{,}000{,}000}{(1+i)^0} - \frac{500{,}000}{(1+i)^1} - \frac{600{,}000}{(1+i)^2} - \frac{288{,}000}{(1+i)^3}\right]\left[\frac{i(1+i)^3}{(1+i)^3 - 1}\right]$$

We want the value of i that makes $k = 0$; but if $k = 0$, the common multiplier on the right

$$\left[\frac{i(1+i)^3}{(1+i)^3 - 1}\right]$$

cancels out and we're left with a relationship identical to the present worth or rate of return methods. Value of i that makes $k = 0$ is $i = 0.20$. Rate of return for the venture is 20%.

Notice the annual cost method has a built-in factor for accommodating different service lives, but this factor drops out when it isn't needed so that equal service lives can be accomodated.

Solution by capitalized cost has a built-in factor for accommodating different service lives. When similar lives exist, as in this problem, the factor cancels out just as in the annual cost method.

If an article or a system lasts m years and incurs an end-of-year expense B_x' at the end of the x-th year, capitalized cost of this single yearly expense is:

$$K = \left[\frac{B_x'}{(1+i)^x}\right]\left[\frac{(1+i)^m}{(1+i)^m - 1}\right] \qquad (7)$$

Nomenclature

B_x'	Yearly expense end of x-th year, dollars.
C	Initial cost, dollars.
(FW)	Future worth, dollars.
i	Interest rate or rate of return, decimal per year.
k	Equivalent uniform end-of-year yearly cost, dollars per year.
K	Capitalized cost, dollars.
L	Salvage value, dollars.
m	Useful life, years.
M'	Uniform end-of-year yearly expense, dollars per year.
(PW)	Present worth, dollars.
x	The x-th year.

Repeated use of Eq. (7) gives:

$$K = \left[\frac{1{,}000{,}000}{(1+i)^0} - \frac{500{,}000}{(1+i)^1} - \frac{600{,}000}{(1+i)^2} - \frac{288{,}000}{(1+i)^3}\right]\left[\frac{(1+i)^3}{(1+i)^3 - 1}\right]$$

For $K = 0$ the common multiplier on the right cancels out leaving a relationship identical to the present worth method. For $K = 0$, $i = 0.20$.

All the methods lead to 20% for the rate of return for the venture.

Methods Are Not Equally Convenient

The two examples analyzed are greatly simplified to allow a brief demonstration of the equivalence of the methods. An extension to more complicated problems and including other factors, such as taxes or even inflation won't destroy the equivalence.

In practice there are minor variations in treatment. Yearly receipts are considered as arriving continuously and subjected to continuously compounded interest in some applications of the rate and return method. This treatment can be extended to any of the methods, if desired. Of course, two methods won't agree exactly unless all amounts are handled consistently in both methods.

Some comparisons in the literature profess a difference between methods. This error usually arises when one author reworks a problem of another author and misinterprets the figures or conditions used by the original author.

Results of an analysis can be expressed in more than one way, such as: pay out time, rate of return, ratio of costs, etc. Regardless of how the results are expressed, they can be worked out by any of the methods, but the methods aren't always equally convenient.

Illustrative problems used shouldn't be the criteria for judging the significance of a method. Relatively small amounts were used in the first example. In a large corporation this is at the maintenance level. Large amounts were covered in the second example and is, by nature, at the management level. Fundamentally, the problems are similar and can be treated by any of the methods.

Presentation of a method by application to management problems doesn't raise it in mathematical preference. Difference between analyzing a $10,000 problem and a $10,000,000 venture is merely zeroes.

In any given problem, no single method reveals information that isn't obtainable by other methods. No single method is applicable to certain types of problems that excludes other methods. Methods can differ in convenience but they're fundamentally all equal in scope.

More can be said about any of the four methods but no more need be said than they are all equivalent.

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Consider These Important Equipment and Safety Factors

- Allow for easy replacement, alteration and maintenance in pilot-plant layout. Changes are inevitable.
- Use only tried and proved auxiliary equipment in the areas auxiliary to the experimental part of the plant.
- Design easy cleaning, repair and inspection features into all equipment to be used in the pilot plant.
- Examine closely all test data from an equipment vendor. His guarantee will not cover a complete plant shut down.
- Provide ample storage areas for materials and equipment. This promotes safe operation by keeping work areas uncluttered.
- Fix well specified areas of responsibility in pilot-plant operations. Fringe areas invite accidents.

Equipment and Safety:

Keys to Pilot Plant Success

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Actual design, selection of equipment, and construction of the facility are critical areas of activity in the birth of a pilot plant. Much time must be spent at this stage paying attention to many details. A minor mistake might upset the operational schedule and delay start-up.

There are a number of critical factors which you should consider —particularly in equipment and design—to minimize delays, breakdowns and accidents in the pilot plant.

A great deal of literature is available on equipment for pilot plants. In addition to the normal industrial units which may be used for large capacity experimental plants, there are many companies which sell items specifically designed for pilot plant service. You can purchase low-capacity pumps, small heat exchangers and valves, and piping components in suitable materials and from a number of vendors. In addition, many manufacturers of process equipment now supply experimental units for pilot plant use as a means of selling their industrial units for the future plant. Miniature kilns, filters, evaporators and centrifuges are available for purchase or rental.

There is another fertile field for the pilot-plant engineer: using accessories sold for the industrial plant. The small pump for adding reagents or additives to an industrial process can serve as the main feed pump for the pilot plant; small coolers or heat exchangers for sample streams or purge lines in a large plant may be suitable as product coolers or heat exchangers in the experimental plant; piping materials normally used for instrument or sample lines in a commercial installation become the main process piping in the small plant.

Many of us remember the time when it was necessary to design and build special equipment to get a pilot plant into operation. This problem does not exist for most unit operations. The major problem, at present, is proper selection and assembly of purchased equipment of suitable specifications. However, considerable thought, planning and experience are still needed for pilot-plant design.

How Much Design Work?

Once the decision is made on the necessity, scope and orientation of a pilot-plant program, the experimental unit itself must be designed.

Amount and extent of the design work will depend on the type of information or product which the plant is to supply, and the procedure to be used in construction.

If the pilot plant is to be also used as a production unit for sample quantities and is a fairly complex system, considerable design time might be justified. If it is planned to have the pilot plant constructed by a contractor with competitive bidding, enough design work must be done to permit a contractor to give a firm price for the equipment and installation. Again each individual case must be decided on its own merits.

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* To meet your author see *Chem. Eng.*, Apr. 21, 1958, p. 186. This is the third in a series of articles on pilot plants. The first, an introduction, appeared in *Chem. Eng.*, Apr. 21, 1958, the second on unit operations appeared in *Chem. Eng.*, June 2, 1958.

A common measure of how much should be spent for design of a facility is some percentage of the total cost. This procedure is used for estimating design costs of production units, but may be quite inadequate in the case of experimental units. However, it does serve as a rough guide for the engineer. For pilot plants costing less than $100,000, between 15 and 25% of the total cost could be spent for design and engineering. For units costing $100,000 to $500,000, the design and engineering costs should be between 8 and 15%.

Design Criteria Differ

The first arbitrary separation which must be made before equipment is selected is to decide what is experimental and what is just auxiliary to the test work. This decision will be governed, to a great extent, by the scope of the pilot plant.

Air, steam, power, water and drainage distributors are normal auxiliary systems which may serve several pilot plants. In most cases the fluid transfer or heat transfer systems will also be auxiliary systems.

The purpose of the auxiliary equipment and system is to serve the experimental portion of the plant. Primary design considerations are: ample capacity, continuity of operation and low maintenance requirements. Do not get involved in unique or untried equipment for this auxiliary service. Obviously, you must consider the characteristics of the material being handled and the length of the operating periods.

In the broad classification of "experimental equipment" as opposed to "auxiliary equipment," it is difficult to make any positive statement without "ifs, ands or buts."

In my experience the most important design feature in a piece of experimental equipment is ease of alteration and replacement. It is not only the time needed to make the change which is involved. If one can make the alteration easily, there is no temptation to struggle with an inadequate piece of equipment trying to make it do.

It must be realized that trouble can occur in the auxiliary portion of the pilot plant. What appears to be a simple fluid transfer may become a nightmare involving emulsions or thixotropic mixtures. You may find, then, that the original scope of your experimental program was in error and should have included the fluid transfer as part of the investigation. Thus you have the problem of additional time and money to complete the program. Be prepared to convert portions of the auxiliary equipment to an experimental basis. Leave room for more instrumentation and for major changes.

Critical Design Points

It is not the purpose here to provide a complete listing of available pilot-plant equipment items nor is it intended to discuss in detail equipment for each unit operation. Instead, equipment has been classified by type with a brief summary of the critical design criteria based on the author's experience.

The reader should again be cautioned about the many variations in pilot plant requirements and conditions.

Use Pumps Wisely

Reciprocating pumps, available in small sizes for low feed rates, are used for many experimental units.

These pumps are only as good as their packing and valves, and the most important features are the design of these components. Both must be easily available for maintenance and replacement. Valve seats as well as ball or poppet should be removable. Packing should be of a standard size easily available from any packing manufacturer. The finish of the packing gland as well as that of the pump rod should be adequate for sealing without too much packing deformation. While the design of the check valves will depend on the material being handled, one can recommend a poppet valve for low-gravity and low-viscosity fluids and a ball-check for high-gravity and high-viscosity fluids and slurries.

A wise precaution: try to use the same type of pump in the experimental program as is to be used in the industrial plant. The centrifugal pump, used for most industrial pumping service, provides a different turbulence than does the reciprocating pump used in most pilot plants. This difference may be quite important for some fluids. A brief pumping test with a centrifugal pump for all pilot-plant liquids suspected of abnormalities, may save much time.

Also remember that small gear and rotary pumps are available and use such units where applicable. These often give a steadier, less pulsating flow than reciprocating pumps.

The reciprocating compressor, as the pump, depends on packing and valves. In addition, the compressor, due to its greater number of strokes at higher speed than the liquid pump, requires more careful lubrication. Packing gland maintenance, particularly for multi-stage units, can be very awkward, and packing life is quite important for such compressors. Most compressors are designed for some leakage through the packing glands. This factor becomes a serious one when an air compressor is used for an inflammable gas without an auxiliary stuffing box.

Columns For Feed or Product

Fractionation and absorption units are usually auxiliary equipment items for product or feed preparation. Design data for the industrial units can be easily obtained from laboratory determinations of vapor-liquid equilibria.

Considerable thought should be given to the use of batch distillation equipment as opposed to continuous distillation. A batch column can make separations which may require several continuous units. In addition, getting a continuous unit into smooth operation increases the operating complexities of a pilot plant and the added hold-up tends to make for longer data collection periods.

If a separation is needed on a continuous basis within the pilot plant it should be designed and instrumented properly. Packed columns are usually specified and care must be taken to obtain good vapor and liquid distribution. Support plates and distributors must be designed for low pressure drops and ample capacity. There are a number of excellent references on design of such columns.[1,2]

One should avoid confusing the design of industrial columns by introducing data obtained from pilot plant operation. It is usually more accurate to design the industrial

column by using vapor-liquid equilibrium data.[2]

Heat Exchangers Are Auxiliary

In most cases heat exchangers are not experimental but supply a necessary auxiliary function. Commercial heat exchangers are usually designed on the basis of physical properties of the fluids involved rather than by using coefficients obtained in pilot-plant tests. In this respect they are analogous to fractionation equipment.

In selecting equipment look carefully at its flexibility, ease of cleaning and simplicity of assembly. Additional expense for a unit which can be easily disassembled is usually well worth while.

A great majority of the heaters in pilot plants are constructed of electrical resistance heating elements. Many problems are encountered with these units. Care should be taken to avoid high watt densities by allowing insufficient heat-transfer area. For a well-designed heater, it should be possible to replace individual elements and to locate quickly any burn-outs or short circuits.

It is good practice to have large heaters in several sections to permit flexibility in control. An ammeter and proper fusing are important in avoiding heater burnout and excess temperatures. Use of electrical equipment for plants handling flammable materials requires careful study.

Piping and Transfer Pointers

Piping systems must be installed to allow for cleaning, maintenance and alteration.

A confused jumble of pipe and tubing often results when changes are made in crowded quarters. This can become a hazard as well as an obstacle to good operation. Be sure to remove all branch lines not actually in use and cap all valved bleed lines not required for operation. This is particularly important for compressor and pump suction lines where a vacuum may be created due to improper operation and air may be introduced into the system with disastrous results.

Use piping connections which are easily made and disassembled and are suitable for leak-free operation. Try to avoid screwed connections for sections which must be removed periodically. This is particularly important for stainless steel pipe for which a good, tight screwed connection is difficult to provide. Use proper hangers and supports, even for temporary systems. Prohibit the common practice of stepping on pipe lines to reach valves or instruments. This is a particularly obnoxious habit when practiced on insulated lines. Be especially careful in supporting and connecting plastic or rubber tubing to avoid breakage or flow interruption.

For piping systems handling slurries, viscous or thixotropic materials there should be ample "clean-out" provisions.

Transporting and handling of solid materials within and to a pilot plant is a difficult task. Most industrial conveying systems are much too large.

In most cases manual movement by drum or bucket is the cheapest and least troublesome solution. The other approach is to convert the solid into a fluid by suspension in a liquid or gas stream. The gas-entrained solid system has become very popular for catalytic reactions. For transport there is a problem of getting down to the small flow-rates required by experimental work. For these the liquid slurry system is preferable. This latter approach also permits the use of a proportioning pump for metering and controlling low flow-rates.

Design Reactor Carefully

Experimental reactors are probably the most carefully designed units in the entire facility. Since each experiment requires a slightly different unit, it is quite difficult to make many generally applicable comments.

The most important criteria for design are sometimes overlooked. These are ease of removal, disassembly and alteration. Every reactor must be taken apart and cleaned. Every catalyst bed must be replaced and sometimes with the use of drills and chisels. Every reactor is altered as more data become available on the process. These seem to be fundamental in all experimental pilot-plant programs.

If the system is designed to permit these operations, easily and efficiently, your program will proceed more quickly. All reactors should have a flanged, or otherwise removable, top or bottom for inspection and cleaning. If it is a flanged opening, one must realize that the metal mass in the flanges will affect the temperature and will heat or cool more slowly than the rest of the reactor.

Catalyst-bed supports should allow for easy removal even when the catalyst is coked or cemented into the reactor as a result of the test run. It is often necessary to extend the length of a reactor to investigate the effect of a different geometry. This should be planned for whenever possible by proper construction and location.

Too Much Instrumentation?

In general, industrial instrumentation equipment is used in pilot plants. There is a sufficient diversity of instruments available for almost every purpose. Occasionally special situations may call for a more rapidly responding instrument.

The two trends in pilot-plant work which must be guarded against are too much and too little instrumentation. Some engineers over-instrument with an increase in complexity for an otherwise simple operation. Conversely, some omit installing instruments and lose valuable opportunities for obtaining additional data. Each process problem must furnish its own criteria for what is just right.

Critically Examine Equipment

By no means have all the types of equipment used in pilot plants been discussed. There is a large group of equipment types which are, in a way, models or prototypes of actual industrial units.

Crushing and grinding tests are often made on equipment of industrial size or a special unit which will supply data suitable for determining the industrial unit. Many of these tests are made by equipment manufacturers for determining the suitability of a particular, possibly unique, item which they are anxious to sell. A similar situation often exists in the cases of filtration units, crystallizers, evaporators, dryers and kilns, and many other types of process equipment.

The pilot-plant engineer must examine each of these experimental units as critically as those of his

own design. All data must be as carefully evaluated. The fact that someone may be guaranteeing the results and performance of an industrial prototype will only cover the cost of the equipment being furnished. It will not adequately reimburse for profit-loss or overhead costs due to an idle plant being repaired.

How To Arrange Pilot Plant

Anyone can evolve an ideal arrangement for any facility, including a pilot plant. However, any really practical approach is, of necessity, a compromise with the costs involved. I prefer to stress the compromises which must be avoided rather than write glowingly of the ideal.

Do not stint on utilities for a pilot-plant area, particularly on power supply for electrical heating. Once utilities are installed, changes involve considerably more expense than a much larger system would have cost originally. The costs for changes to increase utility services can become a large and serious item in a pilot-plant budget.

Provide ample storage for materials and equipment. A well-organized storage system and ample space will greatly improve the efficiency of the pilot plant by avoiding over-crowding in operating areas. Proper storage of equipment will save costs of future pilot plants.

Set Up Safe Practices

There are specific reasons for special consideration of safety in pilot-plant operation. The process or product, developed in the laboratory, has, to this point, been handled solely by technically trained personnel. In the pilot plant we entrust the new operation to nontechnical personnel for the first time. An experimental unit is often a temporary facility, assembled for one or two critical tests. In these cases, planning and inspection are often necessarily hurried and incomplete.

The pilot plant is usually the "birthplace" for the industrial facility and safe practices for the large-scale chemical plant are often based on those used in the test unit. Finally, the enthusiasm and drive of the engineer needed for success in development work is not always tempered with caution for the health and welfare of himself and his co-workers. These reasons place a heavy burden of responsibility for safety on the pilot-plant process engineer.

The fundamental basis of pilot-plant operation assumes careful control of all known variables. An experimental facility which is prone to accidents cannot be definition be a proper pilot plant. Thus safety and productivity are interdependent.

What Causes Accidents?

The most common causes of accidents to personnel are an unsafe act or an unsafe condition in the working area.

Proper design and engineering should be successful in eliminating unsafe working conditions, provided that sufficient thought and effort are expended.

The underlying reasons for unsafe actions by human beings are much more difficult to analyze and eradicate. Heinrich[5] suggests four general reasons: (1) Improper attitude, (2) Lack of knowledge, (3) Physical unsuitability, (4) Improper mechanical or physical environment. Attention to design should improve environment, selection of personnel can eliminate physical unsuitability, and training of personnel supplies the necessary knowledge and information. The greatest obstacle to safety is the attitude of the pilot-plant engineer.

For some unknown reason the mind of the engineer appears compartmented as far as safety is concerned. He will attend to all pertinent details and insist on obedience to precise instructions in any matter which involves smooth and successful operation. When it comes to insisting on adherence to even the most elementary safety precautions, that mental compartment is closed. It is only opened in the presence of the safety engineer or at safety meetings. The pilot-plant supervisor must realize that any accident may retard his program to a much greater extent than minor errors in operation. As yet, not much success has been achieved in this direction.

Practice Good Housekeeping

The greatest single cause of industrial accidents which can be specifically eliminated by attention to design is the one, loosely termed in accident statistics, as "defective agency." This covers slippery floors, worn tools, projecting obstacles, poorly constructed platforms, hazardous arrangements of piping and equipment, hazardous procedures, etc. The bulk of these agencies are just poor housekeeping. Just as some executives keep their desks cluttered to show how busy they are, some engineers keep the evidences of their activity lying around in the plant area. The picturesque, cluttered desk is becoming a thing of the past and it is time the engineer followed this example.

Another common problem in a pilot-plant area, which might contain several operating units, is the apportionment of responsibility. I have witnessed several cases in which incidents happened in these fringe areas where no one was specifically instructed to handle the situation. One common case is scheduling maintenance on one unit without informing the adjacent operating unit. The welding operation going on in the unit being maintained created a hazard for the unit being operated. This type of situation can be avoided by fixed and well-specified areas of responsibility.

The one other point which should be made in this necessarily brief discussion of safety in pilot-plant operation concerns the design of equipment. There are adequate and well-established "codes" for the design of equipment. These must be adhered to in pilot plants.

Most equipment failures are due to slowly acting factors which are inherent in the materials being processed. To avoid these, the engineer must know the material being processed and the materials of construction, and apply this knowledge in design. Furthermore, the design must include provision for human error in adequate relief and venting devices and automatic safeguards.

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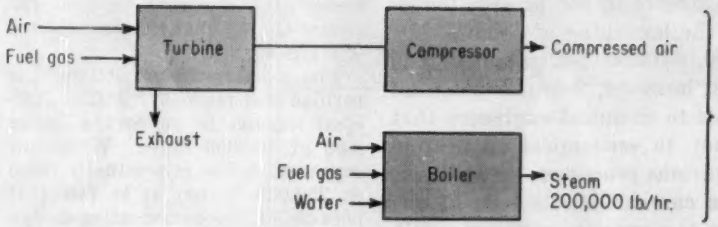
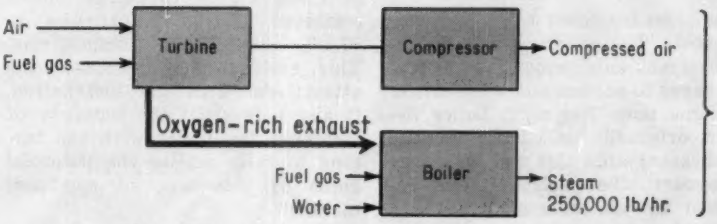


Turbine efficiency: 17%

Combined efficiency as separate units: 66%



With units joined, apparent turbine efficiency jumps to 74%

Combined efficiency: 77%

Gas Turbines Up Process Efficiency

Process applications for gas turbines are few and far between. However, industrial recognition of the worth of turbine-exhaust oxygen may soon change this picture.

J. E. PARKER, Utilities Engineering Supervisor, Union Carbide Chemicals Co., Texas City, Tex.

TO KEEP in line with our rapidly expanding plant capacities, we recently found ourselves facing the need for more adequate compressed-air facilities. The air shortage had been developing for some time, but at a rate that didn't warrant any major installations—some 30-odd portable compressors had partially absorbed the increasing load. Since we felt that more portable units couldn't economically and reliably keep pace with the ever-rising air demands, we decided in favor of some more permanent solution.

Exploring the Problem

An engineering study of the air situation revealed that either a gas-turbine-driven centrifugal compressor or a gas-engine-driven reciprocating compressor would afford a satisfactory solution to the problem. In the course of the study, we had to rule out electrical motors and steam turbines as possible drive units for the centrifugal compressor because of their adverse effect on the plant's steam and power balance.

The most serious disadvantage of the gas turbine is low thermal efficiency. For a single-shaft, simple-cycle machine, the thermal efficiency figures to about 17.2%. Even with a regenerator, this efficiency would only rise to about 28%. In comparison, gas-engine thermal efficiencies range from 24.0 to 33%. Therefore, to make the turbine competitive on the basis of efficiency, effective utilization of its exhaust heat would be necessary.

At about the same time that we started our air-compressor studies, it began to appear that a newly ordered 200,000-lb./hr., 1,000-psi. boiler would be inadequate to meet the expansion's additional power demands. We therefore turned our attention to the possibility of utilizing the gas-turbine exhaust heat for steam generation.

Since the plant needed 1,000-psi. steam at 850 F., we bypassed the idea of a waste heat boiler—calculations showed such a unit to be economically feasible only for our lower-pressure steam needs. Likewise, the prospect of using the turbine exhaust as a heat source in a boiler feedwater economizer met defeat because the amount of heat in the 840 F. turbine exhaust was well in excess of the amount that could be utilized for feedwater heating.

We would like to make a point here of calling attention to the fact that these two possible solutions, which were not justified in our situation, might be attractive to other plants. Successful utilization of gas turbines in process applications depends almost entirely upon prevailing conditions under which they must be applied.

Exhaust Supports Combustion

Then an unexpected solution presented itself because of one of the

*Meet your author on p. 163.

Utilization of combustion gas turbines in the process industries can be likened in one respect to the launching of some of our satellites—off the ground successfully, without realization of full potential. Here the comparison ends, however, because potential uses for gas turbines are still available to chemical engineers that are willing to look for them. The key to economical application seems to be *indirect* integration into various processes. (See Miller, *Chem. Eng.*, Jan. & Feb. 1955.) The current article tells of one unusual and clever gas-turbine solution to a pressing problem.—ED.

basic features of gas turbines that is generally considered to be a handicap, and which causes its low thermal efficiency—high excess air in the exhaust. Since power developed by the turbine is dependent, among other things, upon mass gas flow, and also since temperatures through the machine have to be controlled in line with the capabilities of its materials of construction, the gas turbine has to operate with about 500% excess air. Heat content of this large quantity of air accounts for most of the heat loss in the turbine exhaust.

Due to this overabundance of air, however, the turbine exhaust contains a relatively high percentage of oxygen. Available oxygen amounts to about 18-18.5% of the total flow. This is only slightly lower than that in normal air. The exhaust stream of gas turbines, then, is merely highly heated air. It can be more correctly referred to, therefore, as exhaust air flow rather than exhaust gas flow. It's quite possible that this misnomer has caused attractive applications of gas turbines to be inadvertently neglected.

We should thus consider the exhaust as a secondary heat source for support of primary combustion, rather than as a primary heat source. Realizing this, we changed our thinking, and reviewed the general problem from the standpoint of indirect heat recovery.

Our approach was to calculate how much heat was available if we fired enough fuel to utilize the available oxygen in the turbine exhaust, and reduced the final flue-gas temperature to normal boiler exit conditions. On this basis, we determined that between 250,000 and 300,000 lb./hr. of 1,000-psi. steam at 850 F. could be generated.

Much to our satisfaction, we also found that our newly ordered boiler could be converted to fit these new conditions for about a 10% increase in cost. The primary change required was enlargement of the gas passages to accommodate the larger flue-gas flow. Secondly, boiler design originally called for an air preheater; since this was no longer necessary, the preheater was replaced by an economizer section. With the economizer conversion, deaeration pressure was dropped to 10 psi. to give the economizer a lower-temperature water, thus permitting even greater heat recovery and a lower flue-gas exhaust temperature.

With these changes, the boiler was re-rated for 250,000 lb./hr. when operating on gas-turbine exhaust. Note that only a 10% increase in cost effected a 25% increase in capacity. Of utmost importance was the fact that the resultant increase in steam, obtained indirectly through waste heat recovery, could be supplied at our highest primary presssure, thus providing a most efficient and flexible steam supply to meet the plant requirements.

High Efficiencies, Low Cost

We found that the over-all thermal efficiency of the combined gas-turbine-boiler unit would run about 77.0%. Breaking this down, the apparent turbine efficiency would rise to 74.8%, as compared to 17.2% when operating independently. The apparent boiler efficiency under the combination conditions jumps to 81.6%, as compared to 80.6% when operating independently. Therefore, the most serious drawback of the gas turbine—low thermal efficiency—has been eliminated; and as a matter of fact, the cause for this disadvantage now becomes one of the most important assets. This can be even more readily seen when we compare the new apparent turbine thermal efficiency of 74.8% with the best efficiency (33%) that can be expected of a gas engine.

The exhaust of a 7,000-hp. gas turbine will normally contain sufficient oxygen to support a boiler load of 300,000 lb./hr. While our converted boiler is nominally rated at 250,000 lb./hr., it is felt that because of the conservative design of the gas passes, it will be possible, at least for intervals, to operate at 275,000 to 300,000 lb./hr. Operation at these higher capacities shows combined efficiency increases to 77.4% and 77.9%, respectively. This even further increases the attractiveness of the installation. It also points out the necessity of matching the boiler with the turbine to fully realize the potential gains of this type of combined installation.

The high combination efficiency that we have just mentioned is obviously reflected by a low operating cost. Estimated operating cost per 1,000 cu. ft. of produced air works out to be 26% lower than that for a gas-engine-driven reciprocating compressor. There's also some reduction in steam costs because of higher boiler efficiency. And, significant savings are effected by lowered personnel requirements per unit of steam—the same number of operators can control the larger boiler and gas turbine combination as those required for boiler operation alone. Note too that auxiliary power costs are less since it isn't necessary to operate a forced-draft fan for combustion air. And, finally, simplicity and compactness of the gas turbine gives a worthwhile saving in installation cost over that for a reciprocating installation.

On completion of our engineering study, the turbine-driven centrifugal compressor ultimately showed a definite surplus of advantages compared to a reciprocating installation, as well as an attractive return on the investment. While it will be two or three years before we will have sufficient operating experience to confirm or disprove our decision in favor of the turbine, we feel that we made a wise purchase, and have every reason to expect reliable, efficient, and profitable operation. We believe that the gas turbine offers many advantages as a prime mover, and that the years to come will show an increasing number of installations in industrial processing plants.

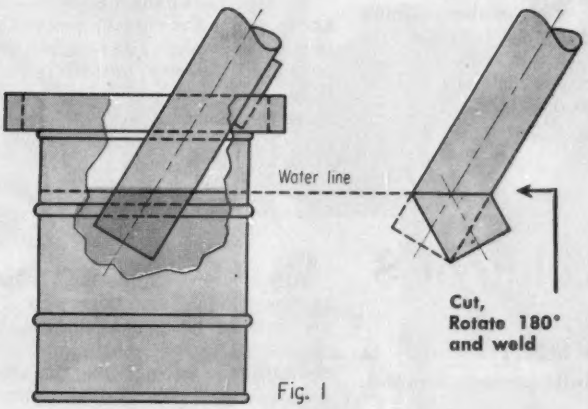


Fig. 1

Easy Way to Fabricate Elbows

No need to recall your descriptive geometry in laying out ductwork elbows if you use this simple water-dunk method.

Chesman A. Lee
Engineer, Evanston, Ill.

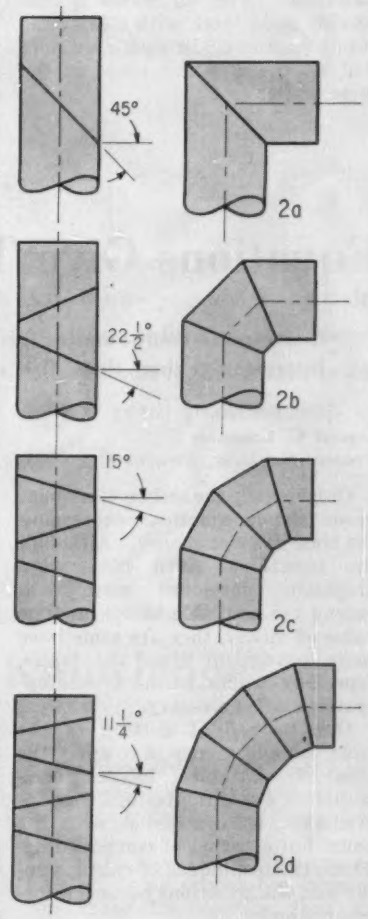
In handling vapors and low-pressure gases we often need fabricated elbows. Since they are sometimes the only thing available, the engineer should know how to draw them up and should even be able to supervise their construction.

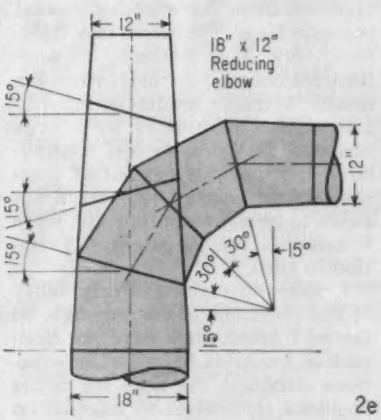
When a draftsman shows such an elbow for fabrication from pipe the joints are merely straight lines on his sketch. The fabricator who is going to form them from sheet metal finds that he must lay out the joints by descriptive geometry, make a paper template and then lay out the resulting sinusoidal curve on the metal for cutting. Or for production jobs, he has equipment based on simple principles which will cut the joint without templates. But in non-production jobs, the idea presented here will do the trick without special machinery and also without the need for templates.

This is the "water-dunking" method—not new to some of the oldtimers, but still novel to a good many engineers.

In the sketches at the right, Figs. 2*a* to *d* show four 90° elbows ranging from a simple one-cut square corner which has little practical utility, to a well-rounded elbow with four cuts. The same methods exactly can be used in designing elbows for other angles than 90°. In every case the cuts are made in the original pipe along the intersection of a plane with the pipe at a suitable predetermined angle, and in every case there will be no waste if the cuts are made carefully.

The trick lies in marking the pipe along the intersection with a plane surface. By dunking in water at the desired angle—Fig. 1—we automatically get the intersecting plane and then simply run a mark around the water level. For this purpose, build a wooden frame on top of a drum of water and rig a movable support within the frame which can be inclined at any desired angle to the water surface. This will ordinarily be between 45° and 78¾°.





2e

When a cut is made carefully along the mark, the cut-off piece can be rotated 180° and will fit perfectly for welding. This is true for each cut of the joint and, obviously, the more cuts (within reason) the better the joint from a hydraulic standpoint. Fig. 2*b* makes a reasonably good joint, with still better ones at *c* and *d*. In each case note that all the cuts are made at the same angle.

The reducing elbow shown in Fig. 2*e* could be made by the same method, starting with a conical shell. Fabricating shops would actually make it by laying out on flat sheet but it is shown here to emphasize that, even in this complex case, the water-dunking method could be used to produce cuts without waste which would match up perfectly, one cut serving for both edges of a joint.

Equations Give Time-Value of $

Continuous compounding gives somewhat higher accuracy in interest figuring than the customary finite-period method.

Gerard C. Lammers
Process Engineer, Stearns-Roger Mfg. Co., Denver, Colo.

Occasionally the techno-economist needs simple equations expressing the time value of money. Although the equations given here were originally developed merely to extend the available tables on time value of money, they are sometimes more convenient than the tables, especially where mathematical operations are necessary.

One method of getting at the time value of money is to apply the idea of continuous interest compounding over infinitesimal time increments, as contrasted with the usual finite period of compounding. Then, the techniques of calculus apply and the equations become somewhat simpler.

In some respects continuous compounding is fundamentally more rigorous than, for example, annual compounding. The saver may question why his interest is compounded once a year only, when his money is made available immediately. Also, cash flows in a large business are more or less continuously moving into and out of projects, so the continuous method appears to be more appropriate, since it accounts for the slightest variation in time.

I make no claim for originality of the equations below although, so far as I know, they have not been readily available before. The equations eliminate the need for tables and lend themselves to solution on the log-log slide rule. All are easily derived by the use of ordinary differential equations.

In simple interest the principal is deposited and allowed to accrue interest. Then:

$$\ln A/P = i\,\theta$$

where P is the principal, i is the interest rate and A is the amount accrued in time θ. Ln, of course, is the natural logarithm.

For a simple annuity:

$$\ln [(Ai + d)/d] = i\theta$$

Here d is the constant rate at which money is being continuously deposited.

The equation for interest and amortization given below is analogous to the simple annuity case:

$$\ln [(d/(d - Ai)] = i\,\theta$$

This equation applies when a loan of amount A is being repaid by a continuous flow of money at constant rate d.

A variation of the simple annuity arises when the rate of payment d is not a constant. The simplest case is when d varies uniformly with time, that is, when $d = a + b\theta$. Here the equation is:

$$A = -\frac{1}{i}\left(a + b\theta - \frac{b}{i}\right) + \frac{e^{i\theta}}{i}\left(a + \frac{b}{i}\right)$$

Any system of units may be used in these equations, although d, i and θ must be consistent.

The effect of continuous compounding is to increase the effective value of the interest rate i. However, the difference compared to annual compounding is surprisingly small. For example, if one deposits $100 for 10 years at 4% interest, the amount increases to $149.18 with continuous compounding, compared to $148.02 with annual compounding. An annuity of $100 a year saved for 10 years at 4% interest comes to $1,229.50 at the end of the period with continuous compounding, while with annual compounding it grows to $1,200.60.

For those who apply the interest-rate-of-return method to profitability analysis, the equations provide a single final equation with i as the only variable. Unfortunately, the equation is implicit and not explicit in i, so that a simple trial-and-error solution will still be necessary.

NEXT ISSUE: Watch for Mid-Summer Winner

★ **How Readers Can Win**

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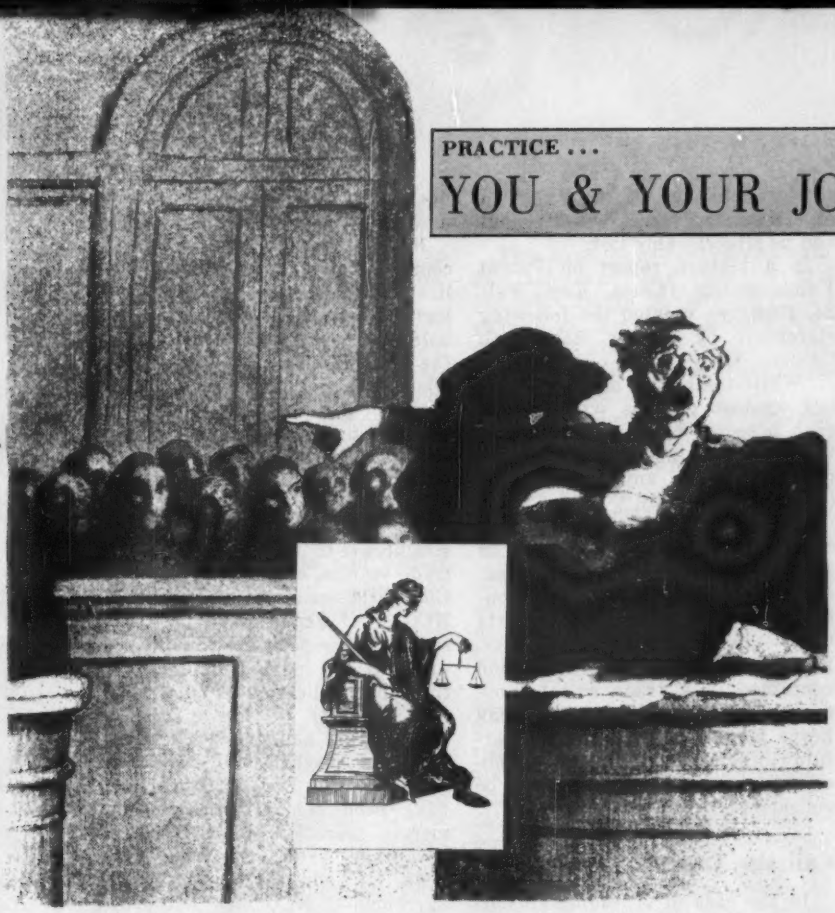
Articles should interest chemical engineers in development, design or production. They may deal with useful methods, data, calculations. Address Plant & Design Notebooks, *Chemical Engineering*, 330 W. 42nd St., New York 36, N. Y.



Some of the engineering know-how you are using today may not belong to you. Here's how recent legal decisions will affect your professional activities.

Does Your Employer Own Your Knowledge?

As a working engineer, the most valuable things you have to offer your employer are your level of intelligence, the knowledge you already possess, your ability to absorb new-found knowledge and your capacity for applying considered judgment toward the solution of engineering problems.

These are the only reliable tools in your kit. Even your automatic fineline pencil and your log-log duplex decitrig slide rule are inadequate companion pieces alongside knowledge and judgment.

Judgment is your own. For now and forevermore. But surprisingly enough, some of your knowledge may not be your own to use. In fact, if some recent decisions in our federal courts remain unchallenged —or are upheld by higher courts— serious doubts will exist about whether any engineer actually owns the information, experience and know-how that constitute his years of engineering experience.

Part of the knowledge you already possess may really be the legal property of your previous employers. You may not be free to exercise unbiased engineering judgment. As a matter of common law and by judicial decree, you may be legally and morally bound to exclude certain information from your thinking. Until now this restriction appeared only in Section 14 of the Canon of Ethics for Engineers. Today it may also be a matter of common law.

We Do Not Take Sides

Now, allow us to make this perfectly clear at the outset. We do not wish to take sides in any controversy now before the courts. We certainly would not presume to be competent to sit in judgment over that which has already been subjected to many hours of judicial review.

We do not wish to criticize any employer for trying to protect through due process of law what rightfully is his property. We do not condone the actions of any employee who deliberately takes as his own that which belongs to someone else.

Most of you reading this are engineers. In all probability, most of you share the opinion that the knowledge that resides within an engineer's skull is something that belongs to him alone and cannot be erased from his brain.

The only purpose of this article is to tell you, via a tour through some recent court actions, that you may be wrong. What you know may belong to someone else. As first stated in Chementator (*Chem. Eng.*, June 2, 1958, p. 43), a judge's decision in U. S. District Court of Utah late in April carries far-reaching implications for every chemical engineer. And this case is only one of several similar cases that have erupted this year.

What Is a Trade Secret?

Most of the cases that will be reported on in this article involve

the disputed ownership of trade secrets, or some dispute concerning what is a trade secret.

Information contained in patents is not at issue here. There isn't much question about who owns patentable information. Only the inventor owns the knowledge, and he alone is entitled to file a patent application on that knowledge. However, if you are typical of most technical employees, you assign to your employer the right to profit from this knowledge. This is in accordance with the terms of some patent agreement that you signed, most likely, when you first started to work for him.

This is a rather common practice in the chemical process industries today. And matters of disputed ownership of patentable information are handled rather routinely by the courts.

In the case of patentable knowledge, the philosophy behind your agreeing to give your employer the benefits of that knowledge and the potential for profit by exercising a 17-year monopoly on that knowledge can be justified quite easily. You are being paid by your employer to be creative and to invent. He helps make the climate for invention favorable, even though you are the only one who can actually patent the invention.

Since you are being paid to invent, your employer is entitled to own that invention after you have made it.

As you already know, patents last only 17 years. They cannot be renewed. If a 17-yr. monopoly on the right to profit from an invention is insufficient, a decision may be made to hold the knowledge in the realm of trade secrecy. However, one who maintains a patentable invention in trade secrecy while using it for commercial purposes always runs the risk that, through changes of employees or otherwise, the secret will leak out and be irretrievably lost.

In a feature report on Patent Fundamentals (*Chem. Eng.*, Feb. 24, 1958) we printed the following statement by author Robert G. Crooks:

"While the courts may grant relief against persons who acquire such a secret by improper means, the courts will not enjoin from using the secret any person who learns it innocently."

Although this statement may have been absolutely correct on Feb. 24, 1958, when it was printed, it probably is not a true representation of the thinking of the courts today—less than six months later. Even if you learn of information contained in a trade secret innocently or by accident, you may never be able to use it. Even certain information obtained by observation and conversation may be considered secret. Here's why.

Call the Docket

In the case of *Monsanto Chemical Co. vs. Charles M. Miller and F. C. Torkelson Co.* the court has upheld in its preliminary findings Monsanto's employee contract which forever forbids Monsanto's employees from disclosing or using Monsanto's trade secrets and confidential know-how. Even information acquired via observation, whether carried in the mind or on paper is included.

Judge A. S. Christenson has also indicated in his preliminary decision that even if Miller had not signed a contract with Monsanto, he would still be bound by common law to preserve the trade secrets which had been revealed to him. In Judge Christenson's own words, "there is no real substantial difference in the matters determinative here between Miller's common law obligation and his contractural obligation."

The case of *National Cylinder Gas Co. vs. R. E. Reitmeier, K. Atwood, P. E. Huber, E. R. Englert, H. W. Fleming, J. H. Miller, J. S. Croheans, W. R. Price and J. L. Parker*, was settled by out-of-court agreement in March. [National Cylinder Gas Co. (NCG) is now a division of the Chemetron Corp.; the individuals named in the suit are all connected with Catalysts and Chemicals Inc. (CCI). Previously all but Parker were employees of NCG's Girdler Corp.]

By court order, NCG's original complaint is not available for publication. However, this much is known about the settlement: A cool half million or more will be paid by the eight former employees of NCG who, with chemist J. L. Parker, formed CCI last summer. The settlement provides for a payment schedule over the next seven years with a guaranteed minimum of $500,000.

In return, CCI has a nonexclusive license to use essentially all the trade secrets, confidential information, processes and know-how of NCG as of Sept. 1, 1957, with respect to compositions, method of preparation, method of manufacture and application of catalysts.

CCI agrees to license NCG to manufacture and sell catalysts that CCI has developed in its laboratories prior to Dec. 31, 1959, which have been demonstrated in commercial operation to have a distinct advantage over competing catalysts. In addition to the above agreements, NCG has withdrawn all charges relating in any way to the ethics or character of the defendants.

Here, we are led to the conclusion that the knowledge considered to be secret probably belonged to the employer (NCG); but that by court action and out-of-court settlement, the former employees now have bought a right to use this knowledge. The price is $500,000 plus.

In the case of *Allied Chemical & Dye Corp. vs. Dixon Chemical and Research, Inc.; Dixon Chemical Industries, Inc.; Arthur W. Dixon, Jr.; Thomas J. Skeuse; Robert H. Dallas; and Louis A. Claveloux*, a consent decree was entered into last month. The decree preserves Allied's ownership of certain secret information concerning plants for the manufacture of hydrofluoric acid, of aluminum sulfate or of sulfuric acid by the process known as the sludge-acid decomposition process.

The consent decree spells out in detail what is considered to be secret information and talks about information furnished by the defendants Skeuse, Dallas or Claveloux, or by "any employee of plaintiff." In a later paragraph we learn that an employee of the plaintiff is any person now or formerly in the

employ of, or hereafter employed by, Allied or any of its subsidiary corporations whether or not this person was employed in connection with hydrofluoric acid or aluminum sulfate.

It would be next to impossible to estimate the number of chemical engineers who are covered by this consent decree. A fair guess is that quite a few of you reading this are directly affected.

In the case of *Eimco Corp. vs. Joy Manufacturing Co.*, Eimco has charged the latter with patent infringements, conspiracy to obtain Eimco's trade secrets and unfair competition. The suit states that Joy not only willfully conspired to copy Eimco's rock-loading and tunnel-driving machinery but also obtained Eimco's production and trade secrets by enticing into its employ Eimco personnel who had been instrumental in Eimco's development program. Consequently, Eimco alleges, Joy Manufacturing was able to produce and sell its new units with a minimum of engineering efforts and expenditures.

Here the proper ownership of engineering know-how is a key point of the case. It is too early for any sort of decision on this one. The information in the paragraph above was supplied by Eimco; our inquiry to the Joy Manufacturing Co., evoked a "no comment" reply.

Employees Win One

In each of four cases cited above the question of who owns certain engineering information forms the heart of the case. We would like to direct your attention now to a case where the right of employees to set up their own business to the detriment of their former employer became the main point of contention.

This time we are concerned with two salesmen. Ben Schacter and his son, Martin Schacter, left the employ of Ardmor Chemical Co., Oakland, Calif., and set up their own business of jobbing detergents, soaps and bleaches.

Ardmor filed suit and obtained a temporary restraining order against the two Schacters. At the hearing of this suit last April, the defense attorney quoted a court decision which read, in part:

"A salesman who leaves one employer has the right to enter the employment of a competitor. He necessarily is possessed of information gained in the earlier employment which will enable him to better succeed in later ones. The doctrine under which injunctive relief is granted should not be given application that would over-emphasize the employer's right to the detriment of the employee by treating as confidential and secret all knowledge and information gained by the employee that might be of assistance to him and later competing employer."

Defense attorney Manfield Davis apparently struck home with this previous decision. Ardmor Chemical voluntarily dropped its charges against the Schacters.

McGraw-Hill's Pacific Coast news bureau questioned Davis after the trial about legal rulings on the ownership of an employee's knowledge. Attorney Davis indicated that for salesmen, anyway, the courts are ruling differently on these cases than they were five years or so ago. Five years ago, an employer charging an ex-employee with soliciting his customers probably could be assured of winning the case. Not so anymore.

Davis was speaking about salesmen. The law for engineers may indeed be different.

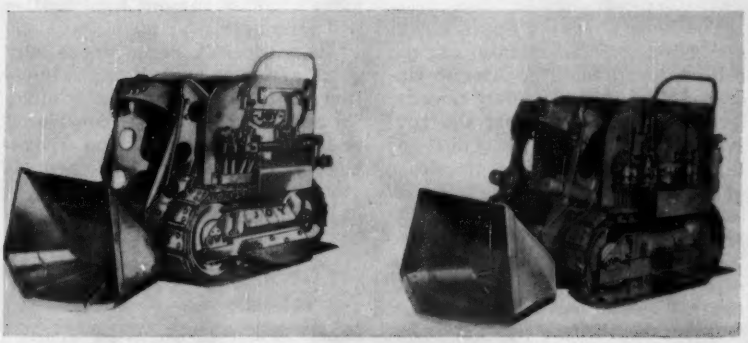
Dangerous to Own

In some of the cases already discussed the employees had signed secrecy agreements with their employers. In other cases they had not. If you have never signed such an agreement or are unfamiliar with its terms, here is what one of our largest chemical companies asks its new engineers to sign:

"Whereas, the Employer is engaged in the manufacture and sale of chemicals, chemical compositions and related products made therefrom, and in research activities for itself and others; and in all such activities utilizes patented and secret methods, processes, apparatus, equipment, formulae and information which constitutes a valuable part of its assets; and whereas, the Employee, whether or not directly engaged in manufacturing or research activities, by reason of the nature of his duties may become informed of such technical information and may be enabled to contribute improvements of new inventions; . . .

"Now, therefore, in consideration of and as part of the terms of employment for such length of time as shall be mutually agreeable, it is agreed as follows: Except as required in his duties to the Employer, the Employee shall not disclose or use at any time, either during or subsequent to the said employment, any secret or confidential information of the Employer (whether or not developed by the employee) unless he shall first secure the Employer's written consent."

You'll note that this particular company sets no time limit on this agreement. Other companies consider 2, 3, 5 or 10 years to be an appropriate limit for the duration of such secrecy agreements. For example, in the consent decree entered into by Allied Chemical and Dixon Chemical, the companies set ten years as the time limit for restrictions on the use of certain secret information. In dealing with the individual defendants, Allied asked for and obtained two-year and three-year limits on some of



FOR THE COURTS TO DECIDE: Who owns the engineering knowledge that went into these machines? Is it Joy Mfg. (left), or Eimco Corp. (right)?

their activities as engineering employees.

Monsanto asks its employees to sign an agreement with no time limit, although as a result of Judge Christenson's decision there may be no time limit as a matter of common law.

(In response to a query on this point, Monsanto reaffirmed the fact that forever is a long time. Actually, Judge Christenson's ruling prevents disclosure so long as such material continues to be protected as a trade secret by Monsanto.)

Charles Pfizer & Co., Inc., asks its employees who work with citric acid information to sign a 10-year secrecy agreement. And this brings us to the interesting point that while an employer may own an employee's knowledge it may be dangerous for the employer to enforce this ownership.

USA vs. Charles Pfizer

In the case of *United States of America vs. Chas. Pfizer & Co., Inc.*, the Attorney General complains and alleges that Pfizer has monopolized the manufacture and distribution of citiric acid, in violation of the antitrust laws.

As part of the complaint, the USA alleges that, among other things, Pfizer "compelled its employees, as a condition of employment, to enter into employment contracts which provide that any such employee, for a period of 10 years after the termination of his employment with Pfizer, would not engage in the manufacture of citric acid either on his own behalf or for others."

At first we thought that the Antitrust Div. of the Dept. of Justice was challenging the legality of such contracts concerning trade secrets. However, our Washington news bureau informs us that the Justice Dept. does not attack in its complaint against Pfizer the legality of employment contracts as such, either of individuals or firms. In and of themselves, such contracts may—or may not—be legal.

What the government is charging is that Pfizer used such contracts as one of several means of acquiring and maintaining an illegal monopoly—and legal means to an illegal end have regularly been condemned under the antitrust laws.

In other words, even assuming such contracts are legal themselves, it is not legal to use them to create an illegal monopoly, says the government.

Therefore, if an employer is particularly sensitive to the possibility of being accused of monopolistic practices, he might do well to avoid asking his employees to sign secrecy agreements. In the Pfizer case the ownership of secret knowledge by the employer rather than by the employee led to the casting of suspicion.

Spevack vs. AEC

We come now to the strange case of *Jerome S. Spevack vs. Lewis S. Strauss, et. al.* Basically, this is a patent case and as such would not belong in this article. However, this case is unusual in that an employee is suing his former employer to prevent him from releasing secret information that belongs to the employee.

The June 9 ruling by the U. S. Court of Appeals in Washington, D. C., is the latest legal development in a running controversy between consulting chemical engineer Jerome S. Spevack and the Atomic Energy Commission over the publication of previously classified information on heavy water.

The court now says Spevack cannot block AEC's release of the information under the Atomic Energy Act of 1954. His only remedy, it says, is a suit against the government in the U. S. Court of Claims for compensation if release of the material actually does amount to "taking his property rights."

Spevack's attorneys are far from satisfied with this. An injunction against release of the information is what they believe Spevack is entitled to. They are not sure that a way can be found to figure damages in order to collect compensation. Thus, appeal to the U. S. Supreme Court is the next likely step—the second time Spevack has gone there to fight the Court of Appeals handling of the case.

For its part AEC says the Spevack case is so unique, that a similar case "would not arise in 1,000 years." AEC itself specifically denies that it ever has assumed authority to publish classified patent applications owned by private individuals. It insists its action in this case is no departure from this position. In effect, what AEC seems to be implying is that while Spevack owns the patent application, the subject matter of heavy water is in AEC's domain and it is free to declassify and release subject matter in that area.

To us this indicates a dispute on the question of who owns an employee's knowledge and the reason we have included this case in this article is the unusual circumstance wherein an employee is suing his employer.

As a matter of additional interest to you as an engineer, when this case came before the Supreme Court in October, 1957, both the American Chemical Society and AIChE (acting through Engineers' Joint Council) filed briefs as friends of the court. This stand by ACS and EJC indicates that this entire question is certainly of immense significance in the world of engineering employment and professional ethics.

Food for Thought

Does your employer own your knowledge? That's for you as a member of the engineering profession to decide for yourself. Perhaps our hop-skip-and-jump summary of these current legal battles will stimulate your curiosity.

There doesn't seem to be any quick and sure answer to the question; no two cases are exactly alike. To answer the question considered engineering judgment and knowledge are called for. Judgment is yours.

But beware, your knowledge may not be your own to use!

Next Issue

Where are engineers' salaries headed?

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Reduce Your Maintenance Costs

You can tighten up your maintenance organization and reduce costs. Check all these possibilities in your plant.

GEORGE C. DERRICK, Chemical Engineer, Research and Dev. Div., Olin Mathieson Chem. Corp., Niagara Falls, N. Y.*

IT'S BECOME increasingly important to control your maintenance costs. Maintenance costs have increased to where they often make the difference between profit and loss.

As time progresses, the maintenance to production cost ratio will assume continually higher values. By the application of industrial engineering techniques and sound management principles, you can effect considerable cost savings.

Here are the various methods you can use to reduce costs in that complex, expensive, yet necessary function—maintenance.

Although it may appear these methods are directed at large maintenance organizations, most suggestions are just as applicable to pilot plant and small maintenance groups.

Reduce Your Maintenance Staff

Even if it appears your maintenance group isn't overstaffed, it's quite possible you can eliminate a few individuals without affecting operations.

After all, data and personal observations aren't infallible. In spite of standard cost systems, job estimating procedures and even though you may think you've optimum labor effiiciency, you can be wrong on your man power requirements.

Assuming no obvious labor deficit exists, you could probably release one or two individuals. If you're going to do this, focus careful attention on all the possible adverse effects such as more overtime or increased downtime of operating units.

This method is a good and direct cost reduction tool but it can backfire with some serious damage to labor-management relations and employee morale.

Invariably, there are other more fertile areas for cost reduction. Of course if you find a maintenance labor surplus and reducing that force won't cause long-term difficulties, then the ax should fall.

An alternative course of action to releasing qualified maintenance craftsmen is to assign them temporarily to production operations. Naturally, you have to consider all the angles of labor contract limitations in this matter.

Better Foreman Training

"But this costs money," is the loud yell management makes. Of course, foreman training costs money, but a shrewd manager knows that to save money you have to spend some—additional pennies to save dollars.

Unfortunately, the chemical industry has lagged behind other industrial groups in this area. Certainly the need for training is everpresent. Desirable results directly attributed to foreman training are:

- Reduction in grievances
- Reduction in inter-group friction
- Reduction in waste
- Prevention of serious accidents
- Increase in productivity
- Management-minded foreman
- Reduction in costs
- Improved group functioning

Foreman training isn't a "crash program." Desired results don't appear immediately and optimum results require continuous training, not merely termination at the end of formal instruction.

Use Industrial Engineering

When a maintenance foreman knows the money he spends on a job is watched (controlled) by his supervisor, a powerful psychological force occurs—resulting in motivation toward lower costs.

An example of this is a maintenance productivity system known as ratio delay.[1] This technique consists of observing, each day, a randomly chosen sample of main-

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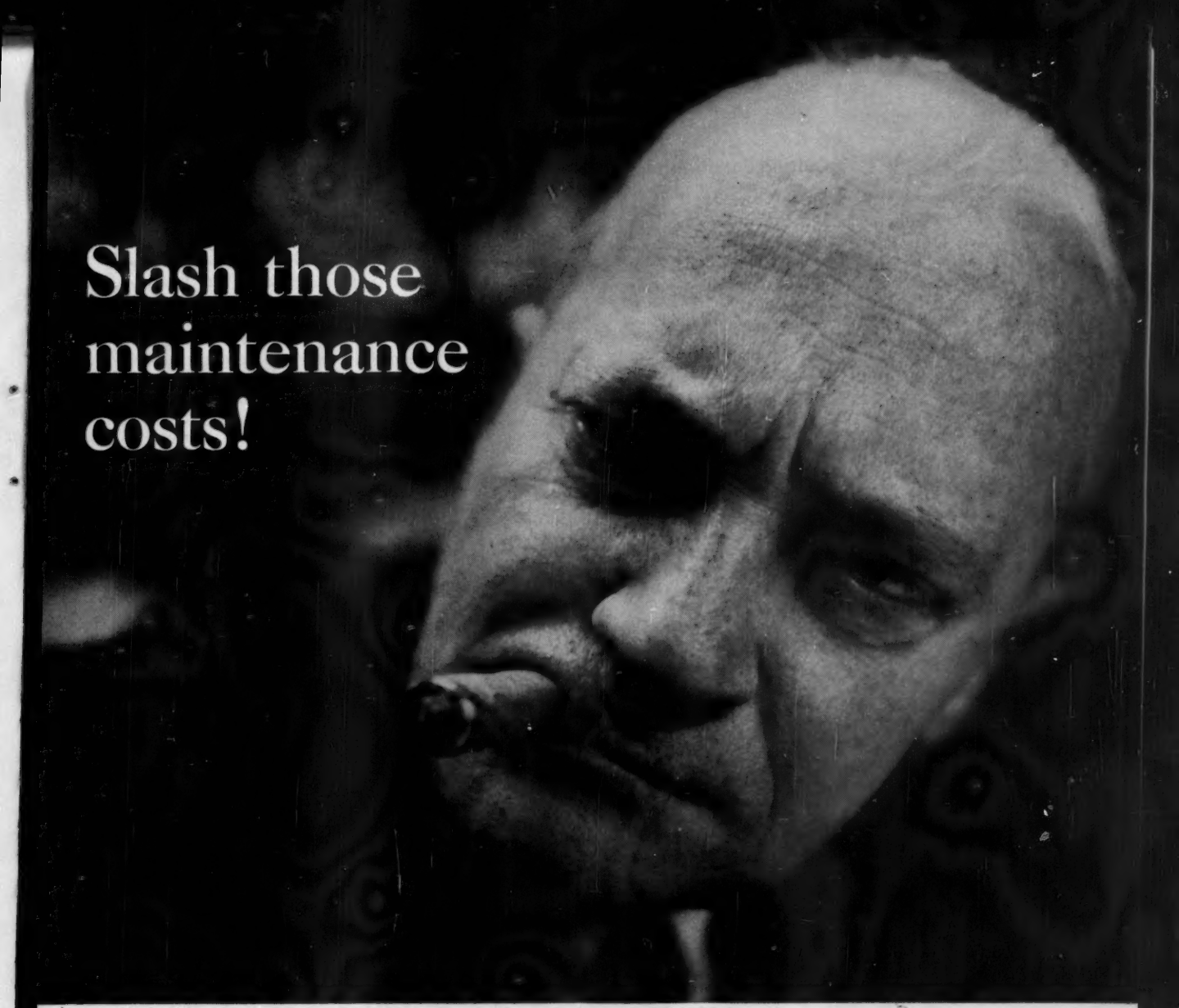

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Check These Cost-Cutting Possibilities

- ☐ Reducing your maintenance staff
- ☐ Training foremen better
- ☐ Using industrial engineering techniques
- ☐ Budgeting and controlling costs better
- ☐ Speeding up the flow of accounting data
- ☐ Designing for maintenance
- ☐ Scheduling maintenance effectively
- ☐ Setting up a preventive maintenance program
- ☐ Decentralizing your maintenance organization
- ☐ Controlling of tools and parts better
- ☐ Correcting any organizational defects

tenance men and rating them with respect to activity at the moment of observation. Adding up the ratings of each man and dividing by the number of men in the sample gives the relative efficiency of the group. You've got to assume this rating is representative of the entire maintenance department.

This system isn't only simple, it's inexpensive. The very fact the men know "they" may be today's sample is a powerful psychological factor in lowering costs.

By applying industrial engineering techniques such as ratio delay you can make significant advances toward more scientific control of costs.

Dow Chemical Co. has developed an extensive cost estimating system based on man hours and historical records that reflect such variables as fatigue, weather, etc.[2] By cost estimating every job over four hours they've been able to:

- Establish manpower requirements
- Control job costs
- Measure labor efficiency
- Make economic comparisons
- Select better materials

Another firm has established time standards for each job and their system[3] works as follows:

First—The maintenance foreman looks at the job, determines the work required, makes a list of materials and prepares instructions.

Then—Number and craft of maintenance workers is established along with the allowable time and the work is scheduled.

And Then—The maintenance worker picks up a combination job-time card arranged in a rack in order of priority. His time on the job is recorded on this card.

Finally—Total costs and labor hours are figured by jobs and comparisons of actual against estimated values are made.

Claims by this company are so high that they maintain each dollar spent saves three dollars in maintenance costs.

This brings up an important point. In developing a cost control-maintenance system, you have to make sure the system will pay for itself. Often, the cost of control is greater than the savings. Systems should be custom-designed for individual plants.

Whether or not spot checks such as ratio delay or more extensive systems are used, routine functions, such as delivery service and preventive maintenance inspection, can be controlled just as manufacturing operations. You should consider them along with production in industrial engineering studies.

Better Budgeting and Control

Budgeting and control of maintenance costs is complicated because: Responsibility is divided between maintenance and production; certain repairs occur irregularly; breakdowns can't be predicted; costs vary with the age of the plant; predetermined job estimates aren't always applicable; and there's little cause and effect relation between maintenance and production costs.

A further complication is the large number of bases that an overall maintenance budget is arrived at, such as: dollar/dollar of investment, dollar/dollar of sales, dollar/lb. of product, etc.

Still, management must have an accurate estimate of projected maintenance costs. Maintenance is important enough for the preservation of property and insuring of production that a sound budget-cost control mechanism is necessary.

First of all, budgeting always provokes application of thought processes. It stimulates action and develops an atmosphere of cost consciousness. Also, it requires the assistance and cooperation of accounting, maintenance and production supervisors.

A good start is to divide the budget into categories: Maintenance of operating process equipment; service activities such as supplies delivery and janitorial service; maintenance of grounds buildings and utilities; preventive maintenance (if you have such a program, which you should); and construction of capital installations.

This technique classifies costs according to areas of responsibility and holds specific individuals accountable for costs within their own cost center. It also does the all-important job of separating maintenance and non-maintenance costs that you usually find together.

As a second step, divide the basic classifications into primary cost centers. For example, operations such as chlorination and nitration will fall under the process equipment category while electrical and painting fall under maintenance of grounds, buildings and utilities.

Once you've established the primary cost centers, actual formulation of the budget is done at a meeting of the appropriate cost center supervisor, the maintenance supervisor and a representative of the accounting department.

At this point, accurate and reasonably comprehensive accounting records are of invaluable assistance. But remember, you can't only rely on historical costs. You've got to take into consideration future costs. These may be influenced by such diverse factors as a scheduled change in operating level, an increase in labor or material costs, an increase in labor efficiency or the anticipation of major repairs.

Using the historical approach and making allowances for anticipated changes you can come up with a realistic budget. Your final step is then to sum up the individual cost center budgets and arrive at an overall maintenance budget. Then compare this figure with past years.

Besides plotting maintenance cost data, you'll find it helpful to determine the ratio of maintenance to operating costs and also plot this index.

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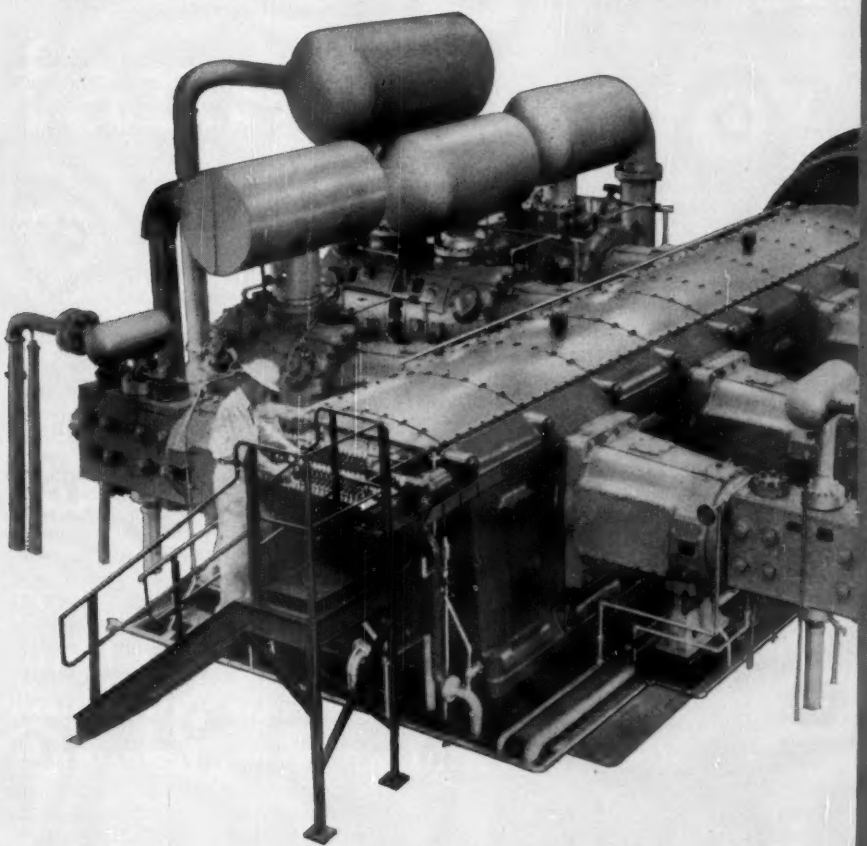

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Estimating the maintenance cost for a plant not yet on stream is a bit more difficult. Common practices run anywhere from looking at the records of the same or similar operations to using a percent of the investment.

Until recently there hasn't been much done to tie in maintenance costs with unit operations or individual pieces of equipment. However, annual maintenance cost/unit of capacity for process equipment such as filters, distillation columns and evaporators has been calculated.[4]

A method that might help is to divide the plant into a number of unit operations. On this basis, repair manhours/year can be reported as a function of the investment dollar with a fixed amount for repair material in dollars/repair manhour.[5]

Although it goes without saying that maintenance costs are harder to budget and control than manufacturing costs, you can set up an effective control. What it takes is a great deal of cooperation, the acceptance of responsibility and a continual re-examination of costs and activities.

Try Speeding Up Accounting

One of the prime requisites of an effective cost control system is to have reports on jobs and overall maintenance performance. This information should be available for analysis as soon as possible. Prompt and accurate reports promote active thinking and result in cooperative efforts for better and less costly work.

Preparation of such reports is assigned to the individuals who prepare cost estimates. Higher level cost control groups prepare overall reports by cost center and for the maintenance function as a whole.

This means you need adequate and qualified cost estimators and accounting personnel in your organization. Although the number of these personnel will vary, a reasonable figure is from two to four for every 100 craftsmen.

The most advance thinking in cost control systems has been the use of electronic computers for integrated data processing. This effects a great reduction in the time required for preparation of such data.

Design for Maintenance

Maintenance begins with design. It's pretty embarrassing to find a beam that prevents your removing a heat exchanger bundle. Too often this happens. Excessive corrosion and equipment failure is at times directly attributable to poor communications between the designer, the process engineer and the maintenance engineer. Significant improvements in operating and maintenance efficiency are attained by requiring the approval of maintenance, production and design groups.

For example: a certain process requires the frequent removal of the top heater on an insulated reactor. By himself, the designer will probably specify a permanent bond-type insulation. Result—soaring maintenance costs. If the designer knows the operating characteristics beforehand, he can call for a removable insulation.

Another unfortunate circumstance is the iron curtain of secrecy placed by federal security regulations or the firm itself. This doesn't only prevent cooperation with manufacturer's representatives but results in excessive maintenance charges.

A situation that's even more aggravating is when the designer isn't told just what he can and what he can't reveal to a vendor's agent. To protect himself, the designer assumes a sphynx-like attitude. Such incidents are avoided if it's clearly stated just how far to go. You can then get the most out of the expert advice a manufacturer's representative has to offer.

Scheduling: A Major Factor

Efficient use of labor is probably the most influential factor in an economical and smoothly running maintenance organization. Optimum use of labor means scheduling of maintenance work and an adequate backlog of work available for unforseen slack periods.

Backbones of efficient scheduling are:

- Existence of a good work order system taking care of regularly scheduled as well as emergency repairs.
- Cooperation of maintenance and production personnel in planning and scheduling maintenance.
- Existence of scheduled shutdowns and a preventive maintenance program.

One method of diminishing idle time is to separate work orders into: those essential to operations and those not essential. Requests that aren't essential to operations are taken care of during slack periods. Certainly, a work order to paint an area that won't be used for some time, or to renovate process control instruments after a pilot plant is shut down, can wait for a while.

Actually, this type of classification system is no more than an extension of the priority system.

Scheduling also means repair equipment and parts will be available when needed. One way to do this is not to call repair crews until all parts and tools they need are on the job site.

One other way to help scheduling and overall plant economy is to calculate an economic balance for all your equipment and materials that decrease in performance with time. This way you can be sure of the optimum time for replacement.

Preventive Maintenance

Preventive maintenance is one of the most effective tools for improvement of labor efficiency and cost reduction. Although it doesn't fit into every plant, process or item of equipment, you can apply it to situations where mechanical failure results in excessive downtime and operating costs, excessive repair costs or personal hazards to operating personnel.

Some people treat preventive and engineered maintenance as separate entities. They state that preventive maintenance deals with the development and execution of a periodic inspection plan for new facilities. Engineered maintenance involves the application of redesign, procurement of better materials of construction and use of engineering techniques on existing equipment.

It doesn't matter whether or not you separate these two important functions of maintenance. They both must exist to have optimum maintenance efficiency.

There are two closely related methods of preventive maintenance:

- Planned shutdown of the entire plant where all equipment is thoroughly checked.

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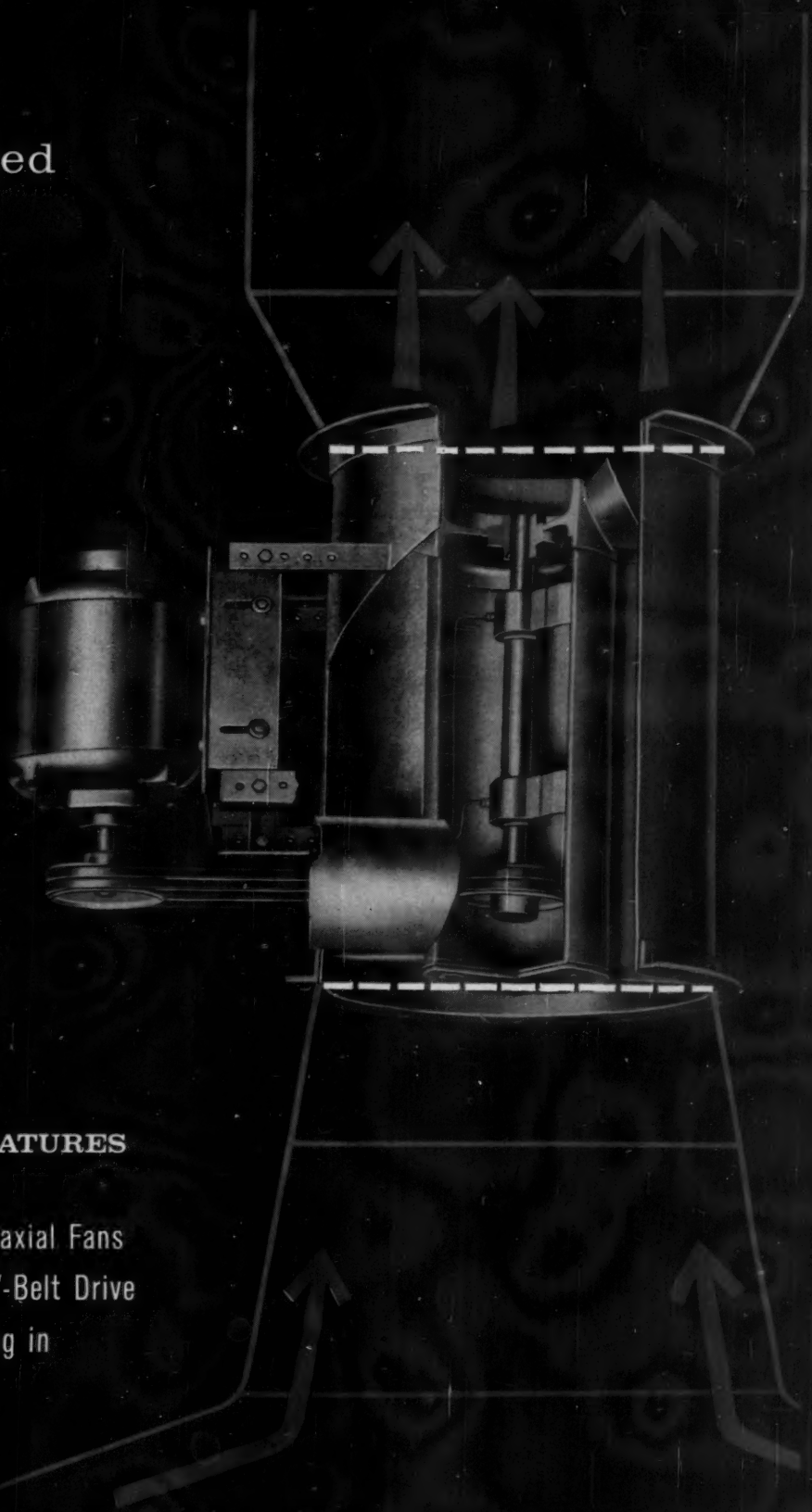

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Unfortunately, the economics of many plants don't allow long and finite shutdown schedules. Since it's hard to shut down entire departments, an alternate plan is to base the program on specific classes of equipment—on a plantwide basis.

As a good start, select classes of equipment, such as weighing devices, where faulty operation most influences the product and cost picture. Not only are cost savings virtually guaranteed, but the selective approach also helps convince top management of the necessity for preventive maintenance.

To run a preventive maintenance program you need: equipment records, a system to schedule maintenance, inspection forms, monthly reports of inspection and mechanical downtime reports.

After you've decided what equipment is included in the program, account numbers are assigned and two cards made up. Information such as inspection cycles and lubrication data is on the first card and used by the maintenance department. The second card contains manufacturer, original cost and estimated life.

Maintenance charges are entered on the second card and a periodic inspection of these charges helps you to detect and correct excessive charges. It also gives you the data necessary for replacement.

An effective preventive and engineered maintenance program requires qualified personnel—including engineers. Such personnel invariably pay their own way many times over.

Although preventive maintenance is usually less costly than breakdown maintenance there are situations where it pays to run the equipment into the ground. Take for instance, a kiln requiring days of cooling to avoid cracking. In this case, preventive maintenance, with frequent shutdowns for inspection, is wrong.

Decentralize Your Maintenance

Decentralization that's effective and economical varies directly with the size of the organization, the complexity of its function and the physical dispersion of its activities. It shouldn't surprise you when an organization stretching over hundreds of acres and employing hundreds or thousands of maintenance personnel, is decentralized. In such situations, decentralization is an absolute necessity.

Two basic forms of maintenance decentralization exist. First is by using area supervisors. Here, craftsmen are assigned to a central maintenance group under a craft foreman. When craftsmen are working in an area supervisor's sphere of responsibility, he becomes their boss. The craft foreman's job is to get the job started and assist the area supervisor.

Conflict in responsibility of the area and craft supervisors is clarified if you consider the area supervisor responsible for the work and the craft supervisor for the worker. It may appear that such an organization violates the principle of single accountability. This generally isn't the case and the divided responsibility doesn't produce any problems.

In the second form of decentralized maintenance, a work crew is permanently assigned to the area supervisor. Additional maintenance personnel for heavier than normal workloads comes by shifting men from other field areas or by requisitioning them from the central shops.

Cost savings are realized if you give maintenance workers free access to small items such as bolts and shear pins without requisitions. Generally, the cost of controlling such small items exceeds any possible savings. To make sure supplies and equipment are on the job when needed, a regularly scheduled delivery service is necessary.

In decentralizing maintenance, responsibility is delegated to the area supervisor. For him to discharge his obligation effectively, he must have enough authority to make decisions and plan his work.

Better Control of Tools and Parts

An inadequate supply of tools and replacement parts reduces labor efficiency and increases costs in the production departments because of lengthened down-time. Often, you find sufficient space and tools aren't provided and even the area serving as maintenance shops is quite dilapidated.

Proper inventory control and sign-out procedures deter pilferage and reduce searching time for scarce items. By incorporating a spare parts inventory program in the maintenance function, you can reduce downtime considerably. Having the right spare parts, in type and quantity, is helped by routing equipment drawings through the maintenance department and having a full-time spare-parts clerk to coordinate action between maintenance and production.

Correct Organizational Defects

Efficient labor utilization is dependent on a sound maintenance organization.

• Your maintenance department must have competent individuals able to get the work out.

• Your maintenance organization must be custom-designed to fit.

• Your maintenance organization needs adequate tools and shops.

• Your maintenance organization must adjust itself to personnel losses. You must estimate future needs for supervisory and technical staff personnel and maintain a supply of promotable key men.

• Your maintenance organization must adjust itself to short-term changes in workload.

• Your maintenance department needs organizational manuals and standard procedures to prevent unauthorized changes in organization structure and procedure.

Insufficient supervision is a most common occurance in organizations of all types. Insufficient supervision is caused by lack of enough supervisors or because the supervisor is bogged down with paper work.

You can't set a numerical rule on the optimum unit of supervision since there's always such a variation in the nature of craft work, the physical dispersion of operating and maintenance facilities and the quality of foreman and craftsmen.

As a rule of thumb, if the unit of supervision exceeds 15 to 17 maintenance craftsmen, you'd better study your organization. Further, for more complex maintenance work, as instrument repair and electrical, it's best to lower the unit of supervision to 8 or 12, and even less under unusual circumstances.

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4. J. D. Leonard, *Chem. Eng.*, Sept. 1951, pp. 149-153.
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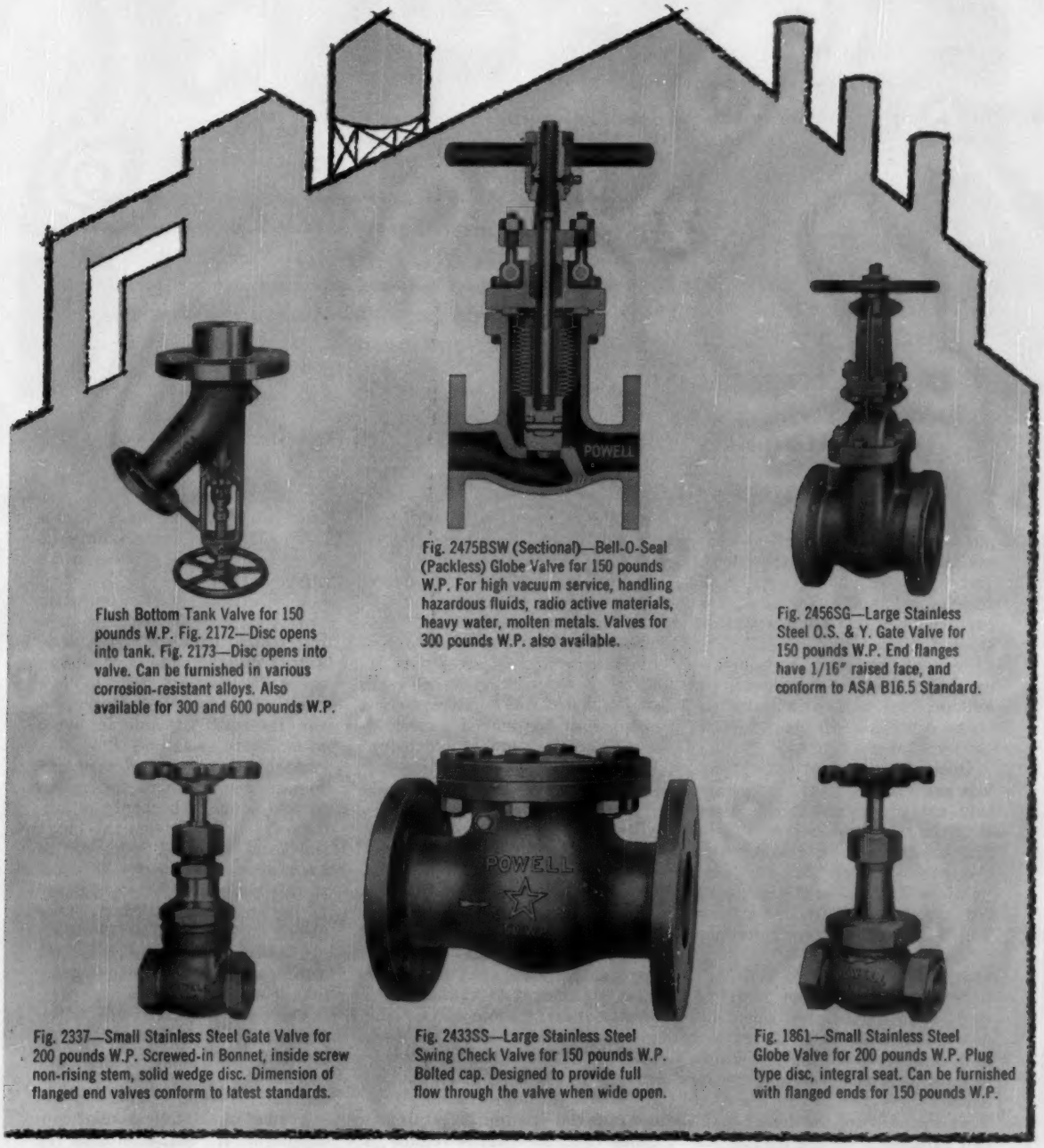


Flush Bottom Tank Valve for 150 pounds W.P. Fig. 2172—Disc opens into tank. Fig. 2173—Disc opens into valve. Can be furnished in various corrosion-resistant alloys. Also available for 300 and 600 pounds W.P.

Fig. 2475BSW (Sectional)—Bell-O-Seal (Packless) Globe Valve for 150 pounds W.P. For high vacuum service, handling hazardous fluids, radio active materials, heavy water, molten metals. Valves for 300 pounds W.P. also available.

Fig. 2456SG—Large Stainless Steel O.S. & Y. Gate Valve for 150 pounds W.P. End flanges have 1/16" raised face, and conform to ASA B16.5 Standard.

Fig. 2337—Small Stainless Steel Gate Valve for 200 pounds W.P. Screwed-in Bonnet, inside screw non-rising stem, solid wedge disc. Dimension of flanged end valves conform to latest standards.

Fig. 2433SS—Large Stainless Steel Swing Check Valve for 150 pounds W.P. Bolted cap. Designed to provide full flow through the valve when wide open.

Fig. 1861—Small Stainless Steel Globe Valve for 200 pounds W.P. Plug type disc, integral seat. Can be furnished with flanged ends for 150 pounds W.P.

For every flow control problem Powell offers more kinds or types, available in the largest variety of metals and alloys to handle every flow control requirement. Powell distributors are located in all principal cities and maintain inventories to fill almost any need. For special engineering problems, write direct to:

THE WM. POWELL COMPANY • *Dependable Valves Since 1846* • **Cincinnati 22, Ohio**

Are costly failures inevitable for austenitic stainless steels under stress? Not if you've considered these practical points:

- *Follow good stress design practices for equipment.*
- *Avoid dead ends and traps where liquid can stagnate.*
- *Rough handling sets up stresses. Handle with care.*
- *Avoid chlorinated solvents for cleaning equipment.*
- *Slowly heat or cool equipment to minimize stresses.*
- *Keep all high-temperature lagging absolutely dry.*

What You Can Do to Reduce Stress Corrosion

Fred J. Poss, Service Metallurgist, U. S. Steel Corp., Pittsburgh, Pa.*

Many problems come with the push to higher and higher process temperatures and pressures. But probably none are more serious or troublesome as stress corrosion in austenitic stainless steels.†

Perhaps someday metallurgical and chemical modifications will produce a steel resistant to stress corrosion. But this doesn't help you now.

Does this mean austenitic stainless can only be used under certain arbitrary conditions where it's thought stress corrosion will not take place? Certainly not. Contrary to much that has been published, there are some very real plant design and operating factors which can greatly reduce this attack.

▶ **Practical Aids**—We will try here to point up some practical rules and principles covering flow conditions, rate of heating and cooling, handling of stainless parts, which you can use to control this serious problem.

The production or design man can rarely act on the sort of information he usually has available. Here are quoted a few examples: "Transgranular cracks in stainless steel typical of those caused by chloride bearing solutions." "Stress corrosion is ordinarily associated with halides to the extent of more than 15 ppm." "One estimate of the threshold stress for columbium-stabilized stainless steel puts it below 10,000 psi. and possibly as low as 3,000 psi." "Stress corrosion may be defined generally as the acceleration of corrosion damage by the application of static stress."

How do you insure that nowhere do chlorides exceed 15 ppm., or that the static stress stays below three or ten or X thousand psi. And how does the steel determine whether the stress is static or dynamic?

▶ **Villainous Halides**—Chlrides are generally thought to be the most significant of the chemical agents that promote stress corrosion cracking in stainless steel. In fact the term "chloride stress corrosion" is often applied to a transgranular cracking failure in the austenitic stainless types (almost without regard to what other circumstances may be involved).

▶ **False Indicators** — Undoubtedly, the poor correlation often found between laboratory tests and plant failures comes from the far greater complexity of conditions in the plant. Let's first look at a service failure in plant equipment to see what might happen:

A stainless steel automatic control valve was installed in a line which handles water containing minor amounts of sludge and sediment and two to five ppm. of chlorides. Operation was intermittent and in some units there was no flow for weeks at a time. A routine maintenance inspection of the valves showed some to be badly pitted. Deposits scraped from the plugs and seats analyzed from 400 to 2,000 ppm. of chlorides. The pH of this water was between 6 and 7, but moistened litmus paper placed on the pitted areas slowly developed pink spots over the pits as the acid corrosion products leached out.

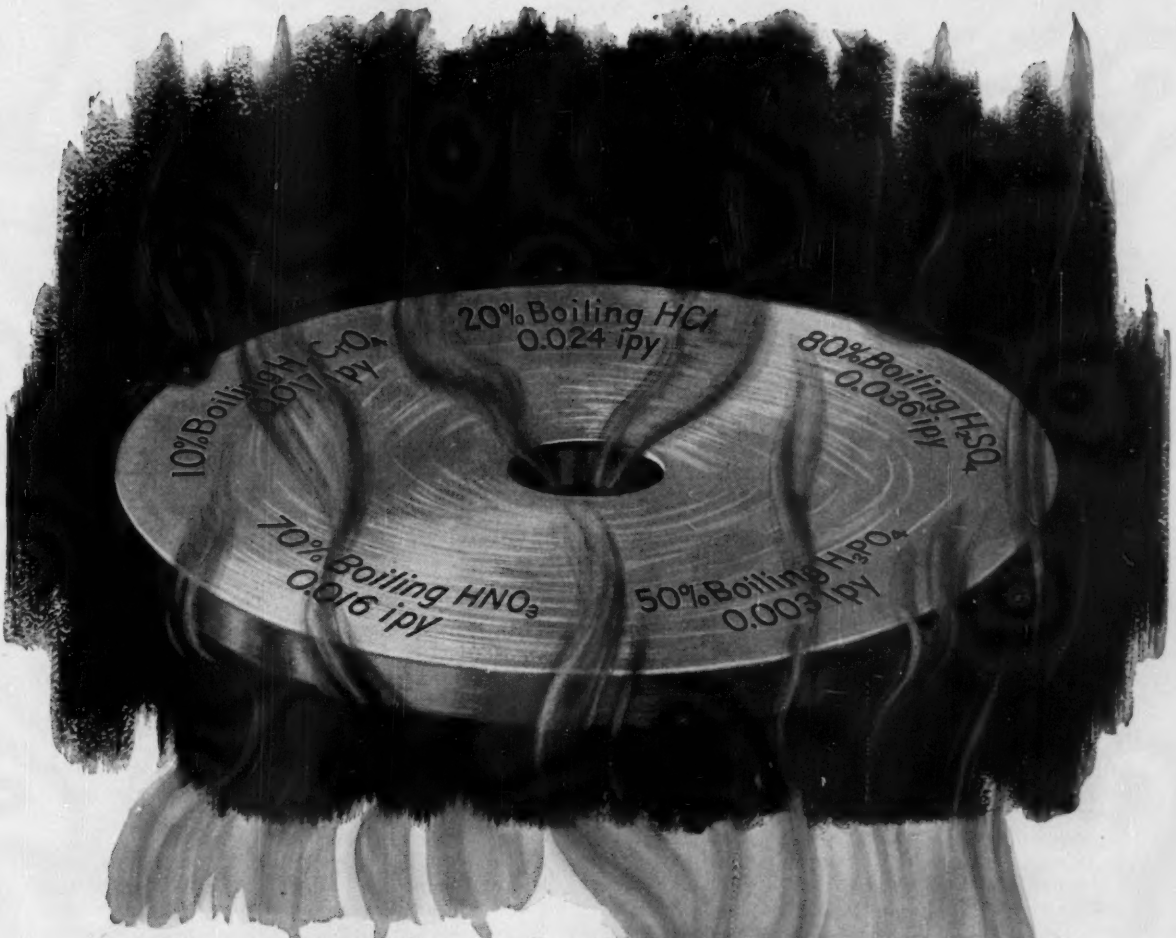
Periodic flushing will often correct this sort of corrosion trouble.

This shows that the bulk concentrations—pH, Cl content, etc.—are not at all indicative of conditions at the actual site of the pit or crack. And it's another reason why failure occurs in a relatively small percentage of the total parts exposed to the same environment.

▶ **Poor Housekeeping**—Another factor that can be very mislead-

* Meet your author on p. 164.

† We will define stress corrosion as corrosion accelerated by stress, usually in the presence of chlorides, that results in cracking.



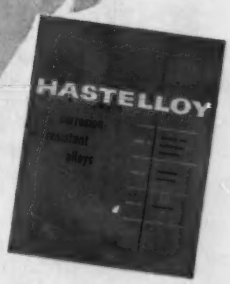
Corrosion from boiling mineral acids?

TEST "HAYNES" ALLOYS

The low corrosion rates on the test specimen indicate the remarkable resistance of HAYNES alloys to mineral acids . . . even at the boiling point. These alloys reduce corrosion damage and product contamination from mineral acids at all temperatures. You will find, too, that they have outstanding resistance to chlorides, halogens, mixed acids, and alkalies.

The penetration rates shown on the disks were obtained as a result of laboratory tests. How closely will they match up with data obtained under actual operating conditions? You can find out for sure by testing them.

We'll be glad to send you samples. But to narrow down the number, we suggest you send us a letter outlining your corrosion problem. For full information on HAYNES corrosion-resistant alloys, their properties, forms, the corrosives they will resist, ask for a copy of our 104-page book.



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ing is to associate the event of stress corrosion or pitting in a vessel or container with the material it is supposed to contain.

We find cases of pitting, in stainless steel liquid containers (drums, etc.), that are attributed to residues of tap water containing chlorides, or to impure steam or to incomplete cleaning and rinsing of the liquids normally shipped in the vessel. Perhaps these are factors, but here again we are usually confronted with a dozen or more of the same items that don't pit under the same conditions.

I once observed three construction workers having some lunch hour target practice in a plant. Target: the opening in a stainless steel drum. Ammunition: Salt tablets. Any time such a vessel is left unsealed in places accessible to people, it is an invitation for them to deposit this sort of material.

▶**Local Conditions Important**—In correlating cracking failures with stress, it's again important that local conditions be considered.

When we read about stress corrosion cracking occurring at very low stresses—stress far below the yield point—these are macrostresses having little if any direct relation with what goes on at the micro-origin of the failure.

The increase in mechanical properties of austenitic stainless steel following cold work is well known, but the ease with which annealed material can be work-hardened locally is often overlooked. In the first case, the increased hardness and strength are measurable by conventional means; but standard tensile, Rockwell hardness, and similar tests don't reveal the shallow (but intense) hardening that can result from careless handling.

▶**Why Tubing Failures?**—Heat exchanger tubing is probably one of the more critical applications in which stainless steel is used. It's also one of the services in which stress corrosion failures are frequently reported.

This expensive item has been observed to be handled with no more care than would be given concrete reinforcing rods. The result is badly scuffed, scratched or bent tubes in many cases. Sometimes when assembling the bundles, the holes through the baffle plates do not line up exactly so the tube will rotate as it is forced into the bundle through the successive baffles. The writer has inspected failed tubes where the pattern of stress corrosion pits and cracks lined up in a spiral pattern very suggestive of such practice.

We suspect many of the failures of this type originate in these "bruises" caused by contacts with other hard objects. Certainly most of the causative conditions often postulated are present: strained metal, residual tensile stress, reduced ductility and all in a localized pattern that seems to be characterized by its inconsistency.

▶**Relief Techniques**—Commercial tubular products are generally furnished in the annealed condition unless cold drawn properties are specified.

For the austenitic grades, a water quench from the annealing temperature is given to hold carbides in solution and give maximum corrosion resistance. But, a rather severe straightening operation must follow to remove the quench distortion. This is done by Medart rolling. The product has significantly higher strength and hardness after this step than does fully annealed austenitic stainless steel. Electrolytic etching, or grinding, of mill straightened tubing reduces the frequency of stress corrosion cracking under test conditions.

▶**Check Operating Conditions**—We have seen stress corrosion cracking defined as the acceleration of corrosion by static stress. This has been adequately confirmed to be possible in several excellent papers on the subject. But we doubt the authors meant to infer that this form of failure results only from this form of stress.

A considerable number of case histories seem to reflect such thinking for we see "high internal stresses from fabrication, forming, etc." given as the cause even though in operation the equipment was transferring heat or was being heated and cooled under the most adverse circumstances imaginable. Or the same diagnosis may be made where the part operated for a long period and then failed soon after someone raised production to 150% of maximum design capacity.

The investigator must recognize that an increase in operating rates means more steam or fuel, higher heating rates, more vibration and thus, more stress on the equipment. And here, again, the investigator doesn't always get this sort of information from the operating people—even if he thinks to ask for it.

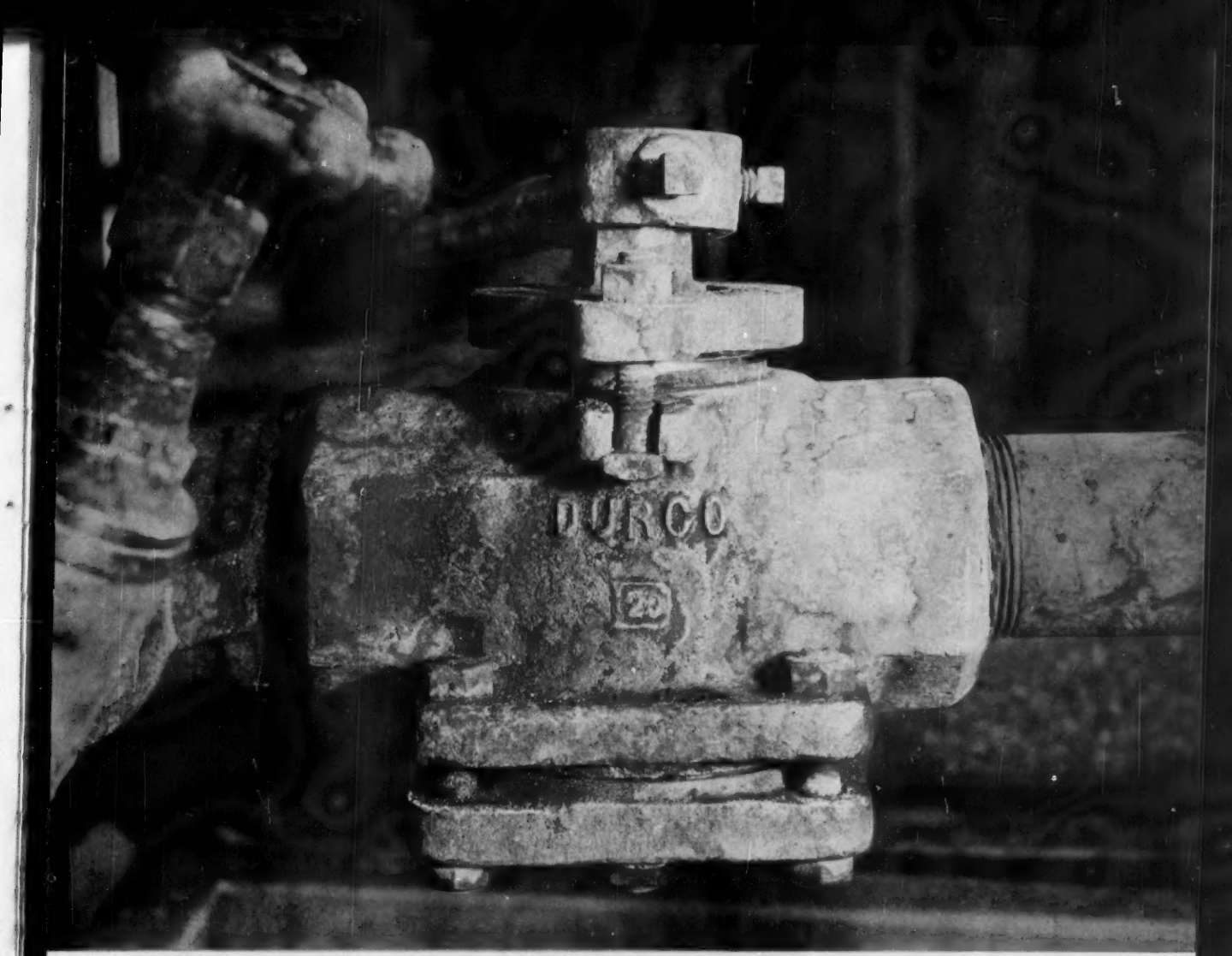
▶**Consider Properties**—Austenitic stainless steels are excellent for high temperature applications, and certainly they withstand stresses very well. There are however, some properties of the material that need to be recalled. These are: its high thermal expansion, poor heat transfer, and the susceptibility to work hardening discussed previously. The first two result in higher stresses in the equipment than would occur if a ferritic steel were used under the same conditions of heat transfer or temperature change.

Designs that appear very conservative when based on normal stresses at normal operating conditions may become badly over stressed if rates and frequencies of heating and cooling are not controlled carefully.

There is also a danger of associating safe design with increased strength and rigidity; when thermal expansion is the factor, the stronger and stiffer structure will be the more highly stressed. Flexibility is what's needed here. Only good design plus controlled operating conditions can achieve the proper balance between this and the required strength for pressure containment, etc.

▶**What To Do**—To reduce stress corrosion of stainless steel under plant operating conditions:

- Follow established good design practices in fabricating and assembling high temperature equipment for processing or testing. This means piping stress analyses in some detail.
- Avoid dead ends and other traps where liquor and/or sediment may stagnate. Where these are inevitable, provide a means of periodic flushing or process



Absolutely no maintenance costs in four years of tough chemical service

This DURCO type F valve on the bottom outlet of an arsenic acid recovery tank has served Abbott Laboratories for four years with absolutely no maintenance: dependable service that is hard to beat.

DURCO type F valves with renewable Teflon sleeves are available in sizes from ¼" thru 4" in stainless steel and a wide range of corrosion resisting alloys. These DURCO valves have proved their reliability in tough chemical services in thousands of applications since 1950.

For dependability, insist upon DURCO. The DURCO type F valve will not stick or gall, requires no lubrication, has reverse-taper plug and simple adjustment to insure positive shut-off.

Abbott Laboratories is one of the world's leading manufacturers of pharmaceutical products. For nearly 70 years Abbott has been devoted to serving mankind through the preparation of standardized, dependable drugs including anesthetics, antibiotics, radio-pharmaceuticals, and nutritional products.

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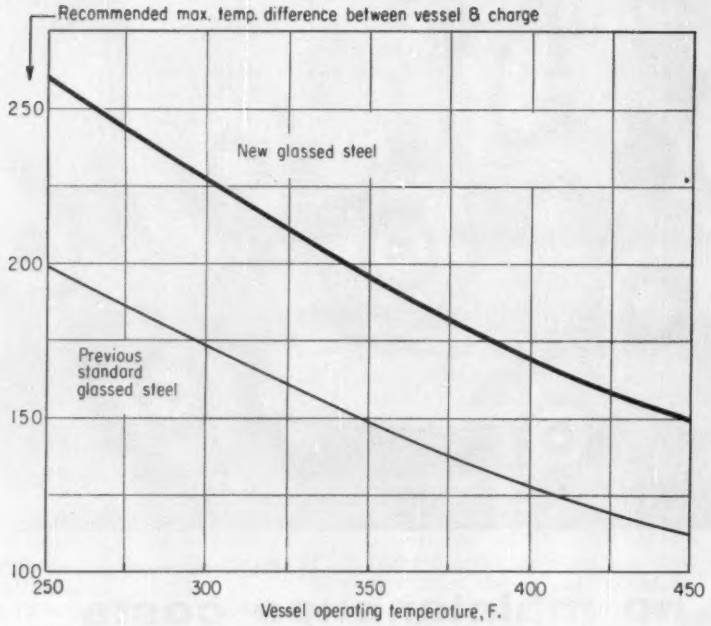
flow periodically. For example, flush by-passes occasionally.

• Avoid careless handling of tubing and other small parts that may be subject to high service stress. Thousands of dollars spent on carefully annealing the material may be wasted if it gets banged and dragged on hard surfaces. A lot of stress corrosion failures originate in the resulting work-hardened areas.

• Don't use cleaning agents that can double as pickling solutions on assemblies or sub-assemblies of stainless steel. It doesn't take much residual hydrochloric or hydrofluoric acid to cause corrosion later and it's practically impossible to remove these completely from an assembled system of any complexity.

• Don't rush the heating and cooling of vessels or heating sections made of stainless steel. Particularly watch strip heaters or other local contact types. They set up tremendous thermal stresses in the vessel wall if energized too rapidly.

• Keep lagging on all high temperatures lines and fittings and keep it dry. Wet insulating materials do not insulate and they may be very corrosive to the metal they cover.



Better Shock-Resistant Glass

New glassed steel offers added resistance to thermal shock damage; extends use of glass-coated equipment.

A new, tough glass with improved abrasion and thermal shock resistance has just been introduced by the Pfaudler Co., Rochester, N. Y.

Called Glasteel 59, it is used to coat steel. The material as coated has 30% greater thermal shock resistance, 20% greater abrasion resistance, compared to standard glass. It costs about the same as the older glass.

Pfaudler claims maximum allowable temperature difference, formally 200 F., is now 260 F., where the vessel temperature is 250 F. (see curves above).

Actually Pfaudler engineers have not come up with a totally new glass composition. Instead they've developed additives which go into borosilicate glass. These additives reduce the number and size of air bubbles always present in glass after it's coated on steel. Bubbles in standard glass coats, are large and unevenly distributed, become weak links in the glass structure and reduce shock resistance. The new glass still has bubbles, after it's applied to steel, but they are small, evenly distributed and not as numerous.

▶ **Resists Corrosives**—New material resists all acids except hydrofluoric. It can be used with acids up to 325 F. without damage, and under certain conditions this can be extended to 450 F. To alkalies, its resistance is about twice that of hard-glass labware.

▶ **How It Works** — Thermal strength of any glassed steel depends on two factors: the base metal to which the glass is applied, and the glass formula.

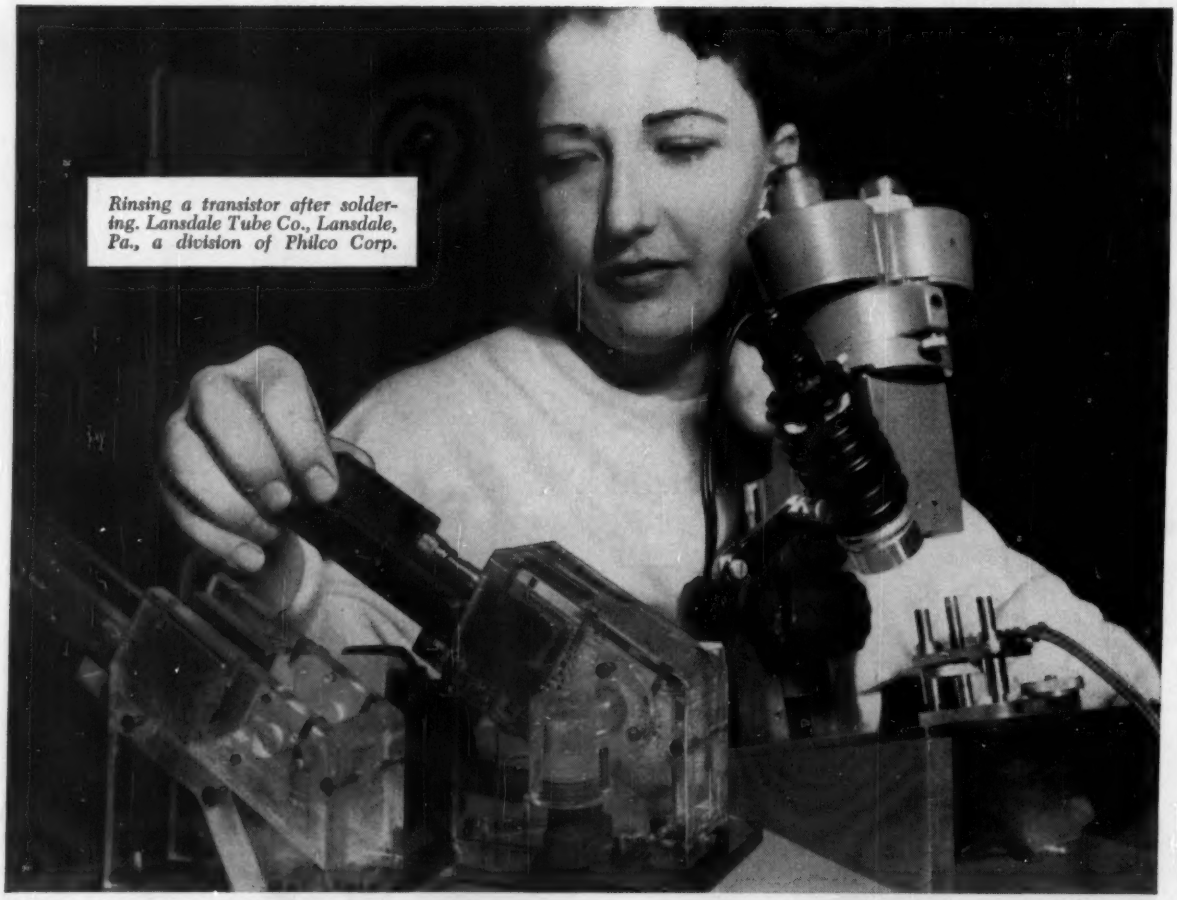
The coefficient of thermal expansion of glass is intentionally held at a lower value than that of the base steel. Then the glass layer is in compression after the system cools from firing.

Glass is exceptionally strong under compressive stresses. It has a modulus of elasticity ⅓ that of steel, and it's usually applied to a thickness about 1/10 of the base steel. This puts the glass in compression and stretches the steel as the composite cools.

Amount of compression in the glass is approximately 30 times that of the steel tension so a high level of compressive stress remains in the glass. This cushion makes the finished product mechanically serviceable as long as other stresses do not take the glass out of compression.

Resident compressive stress in glass gradually decreases as its temperature rises. So permissible thermal shock tolerances depend upon the operating temperature of the vessel.

Careful control of these factors, plus the reduction in bubble formation, are key factors in the new glass.



Rinsing a transistor after soldering. Lansdale Tube Co., Lansdale, Pa., a division of Philco Corp.

How 99.999992% pure rinse water helps make Philco transistors last longer

Tiny transistors are the heart of the electronic circuits in military radar, computers, the radios in our satellites.

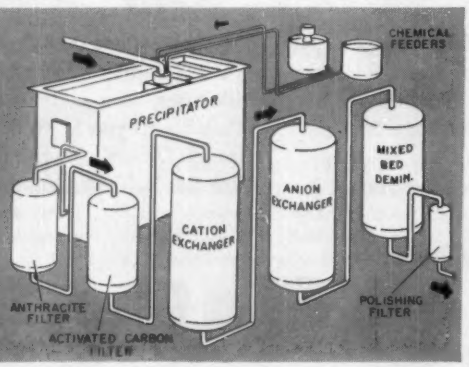
But . . . infinitesimally small, unmeasurable amounts of impurities on the surface of a transistor can greatly affect both its performance and its life . . . may even send it to the reject pile.

That's why water for grinding and lapping the basic germanium or silicon and for etching, plating and rinsing transistors must be as pure as is practically possible.

The Permutit equipment (below) at Lansdale Tube Co. removes final traces of turbidity from city water, then reduces the mineral impurities from 168 parts down to 1/12 of one part per million! That's 99.999992% pure!

High-grade water solves quality-control problems in many industries . . . in finishing, plating, chemical solutions and reactions. We'd like to discuss it with you. Address: The Permutit Company, Dept. CE-78, 50 West 44th Street, New York 36, N. Y. or Permutit Company of Canada, Ltd., Toronto 1, Ont.

Demineralizing process water *"Precipitator" removes most turbidity, hardness and iron. Anthracite filter removes remaining suspended matter. Activated carbon filter removes color and dissolved organic matter. Cation, anion and mixed bed units reduce dissolved solids to minimum. Polishing filter removes traces of suspended matter.*



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FIRMS IN THE NEWS

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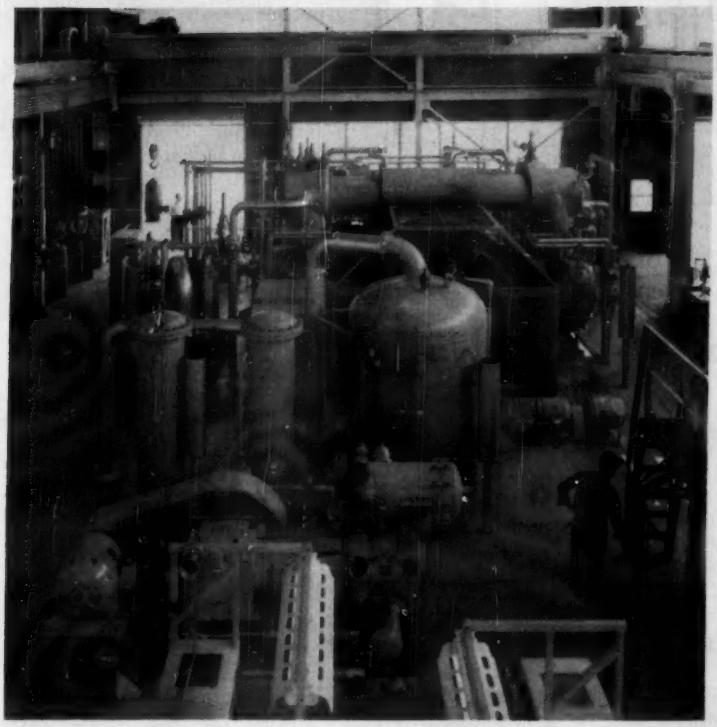
NEW FACILITIES



New Airco Plant to Help Spawn Transistors

Air Reduction Co.'s new $9-million liquid oxygen, nitrogen and argon plant at South Acton, Mass., was recently dedicated, is now producing at a 75-ton/day clip. Large consumer of plant's output will be the fast-growing electronics industry: Germanium and silicon crystals used in transistors are grown in inert atmosphere of argon or nitrogen.

Dow has placed a new glycerine plant on stream at Freeport, Tex., doubling capacity for synthetic, 96% USP and 99.5% USP grades. Secret processes developed by the Texas Div. used in new plant yields purer glycerines than their previous counterparts.

Wyandotte Chemicals' ethylene oxide-glycol plant has been swung on stream at firm's Geismar, La., works; first half of a 300-ton/day chlorine and 330-ton/day caustic soda plant is well underway and is scheduled to go on stream in first quarter of 1959. Geismar works marks firm's first sizable investment outside of Michigan and will total $37 million.

AFN, Inc., has started operation of a high-energy boron fuel pilot plant for the Air Force at the Henderson, Nev., plant of American Potash & Chemical Corp. AFN is owned jointly by American Potash, Food Machinery & Chemical Corp. and National Distillers.

Allied Chemical's productive capacity for its A-C polyethylene resin used in plastic pipe has been "substantially increased" at company's Tonawanda, N. Y., plant. Allied says expansion will now make it possible to offer the resin to entire pipe industry.

FIRMS . . .

Stauffer Chemical's Consolidated Chemical Industries Div. has just brought an anhydrous HCl plant on stream at Fort Worth, Tex. New facilities, producing a 99.5% product, will supply petroleum refineries and chemical makers in the South, Midwest and East.

West Virginia Pulp & Paper Co. is now in production at a new multiwall and grocery bag manufacturing plant at Torrance, Calif. This is first of firm's operations to be established west of the Rockies.

Pittsburgh Plate Glass has started up new production facilities for its recently introduced line of polyester resins for urethane foam at the Ditzler Color Div. at Detroit, Mich. Firm has also dedicated its new mile-long glass plate factory at Cumberland, Md., erected at a cost in excess of $34-million.

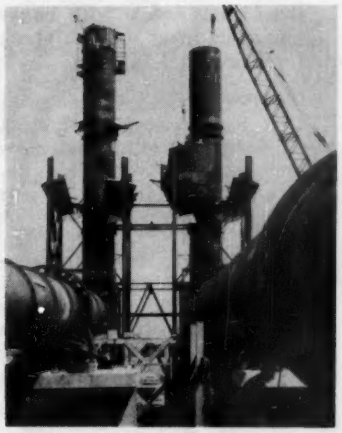
Linde has erected a new 65-ton/yr. oxygen producing plant at the eastern end of the Mesabi Range to supply mining pits at Minnesota's largest taconite plant. Oxygen will be used in jet-piercing operations—a new process for drilling taconite by using oxygen-kerosene jet flame.

American Enka Corp., as a major step in its expansion program, has started production of nylon in a new multimillion-dollar plant at Enka, N. C. When in full production, Enka's production of fine denier nylon textile yarns will be nearly tripled.

Abbott Laboratories has broken ground at North Chicago, Ill., for a major research center addition, largest project in firm's 70-yr. history. Eight-story glass and steel structure will more than double space available for pharmaceutical research and development.

Air Products has placed a new oxygen-generating plant on stream at Phoenix Iron &

Steel Co., Phoenixville, Pa. Unit can produce 7.5 million cu. ft./mo. high-purity oxygen for surface preparation of ingots used in seamless tube and pipe mill.



General Carbon & Chemical Co. is increasing capacity for electrode-grade carbon by 720 tons/day with the addition of two 180-ft. petroleum-coke calcining kilns at Robinson, Ill. Photo shows raw material bins under construction at feed end of kilns.

Union Carbide Chemicals is revising construction timetable for several projects: Construction is about to start on a new technical service laboratory near Tarrytown, N. Y., that had been deferred in February pending further study. Firm is also restudying plans for expansion of ethylene oxide and ethanol facilities—petrochemical plant at Putnam, W. Va., scheduled to be completed early in 1960, will be delayed pending outcome.

Sierracin Corp., Burbank, Calif., has added a third plant for production of company's new transparent, electrically conductive coating. Building supplies additional 12,000 sq. ft. manufacturing space.

West Branch Refineries has placed a new 1,150-bbl./day Houdriformer in operation at firm's West Branch, Mich., re-

FIRMS . . .

finery for production of high-octane fuels from Canadian and Michigan naphthas.

Alcon Laboratories, Fort Worth, Tex., manufacturer of rhinologic and sterile ophthalmic pharmaceuticals, has started construction on the first unit of a $1-million group of buildings; new unit will house manufacturing and shipping facilities.

H. K. Porter Co.'s Refractories Div. has boosted production capacity for silica brick by more than 50% with installation of a new production unit at Canon City, Colo.

United Refining is starting construction on a new crude unit that will bring capacity of its Warren, Pa., refinery up from 8,000 bbl./day to 15,000 bbl./day. New unit is part of a $1.5-million plant revamping.

MERGERS & ACQUISITIONS

Aluminum Company of America announces plans to start production this fall in two new potlines at its Massena, N. Y., works, completing the first phase of a multimillion-dollar modernization and expansion program at this location. Two new potlines will supply an additional 72 million lb./yr. aluminum.

American-Marietta, planning further expansion in chemical field, has signed an acquisition agreement for assets and business of Southern Dyestuff Corp. of Charlotte, N. C. Sodyeco's principal business is supplying vat, sulfur and pigment dyes to manufacturers of cotton and other cellulosic fabrics.

Morningstar-Paisley, New York, N. Y., has acquired Thurston & Braidich, importer and processor of water-soluble gums, for an undisclosed amount. All manufacturing operations will be moved to Morningstar's recently completed gum processing plant at Hawthorne, N. J.

CALENDAR

Gordon Research Conference, Elastomers, Colby Junior College.
Aug. 4-8 New London, N. H.

Gordon Research Conference, Radiation Chemistry, New Hampton School.
Aug. 4-8 New Hampton, N. H.

Western Packaging and Materials Handling Exposition, San Francisco Civic Auditorium.
Aug. 11-13 San Francisco, Calif.

Gordon Research Conference, Chemistry and Physics of Metals, Kimball Union Academy.
Aug. 11-15 Meriden, N. H.

American Institute of Chemical Engineers-American Society of Mechanical Engineers, Second National Heat-Transfer Conference, Edgewater Beach Hotel.
Aug. 18-21 Evanston, Ill.

Gordon Research Conference, Inorganic Chemistry, New Hampton School.
Aug. 18-22 New Hampton, N. H.

Gordon Research Conference, Chemistry of Adhesives, New Hampton School.
Aug. 25-29 New Hampton, N. H.

The Combustion Institute, 7th international symposium, Oxford University.
Aug. 28-Sept. 3 Oxford, England

Second International Conference on the Peaceful Uses of Atomic Energy, sponsored by the United Nations.
Sept. 1-13 Geneva, Switzerland

Cryogenic Engineering Conference, Massachusetts Institute of Technology.
Sept. 3-5 Cambridge, Mass.

Federation of Belgian Chemical Industries, 31st International Congress of Industrial Chemistry.
Sept. 7-20 Liege, Belgium

American Chemical Society, 10th national chemical exposition, International Amphitheatre.
Sept. 9-12 Chicago, Ill.

Technical Assn. of the Pulp and Paper Industry, 3rd International Mechanical Pulping Conference, Chateau Frontenac.
Sept. 10-12 Quebec, Que.

American Assn. of Textile Chemists and Colorists, Delaware Valley Section meeting.
Sept. 12 Wilmington, Del.

Society of Plastics Engineers, Technical conference, St. Clair Inn.
Sept. 12 St. Clair, Mich.

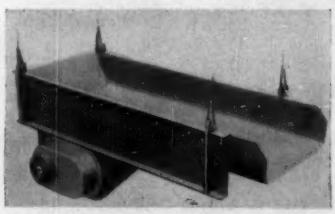
The Society of Chemical Industry, travelling conference to view Canadian industry, starts at Chateau Frontenac.
Sept. 11-23 Quebec, Que.

Instrument Society of America, 13th annual Instrument-Automation conference, Convention Hall.
Sept. 15-19 Philadelphia, Pa.

(*Continued from p. 80*)

the operators via alarm, or automatically operate control switches.

Roto-Guard consists essentially of a pump that forces a fluid against a diaphragm controlling an on-off electric switch. Designed for direct coupling with 10- to 150-rpm. machinery shafts, or via reduction gears for higher speeds.—**Bin-Dicator Co., 13946-42 Kercheval Ave., Detroit 15, Mich.** **80E**



Vibrating Feeder

Ideal for applications involving limited headroom.

For high-tonnage feeding of bulk materials, including lumps up to 36 in. dia., the new Link-Belt feeder utilizes two counter-rotating eccentric shafts to produce a high-intensity straight-line stroke, ranging in amplitude from ¼ to ½ in. Vibrator speed (900 cps. max.), material depth and trajectory are all adjustable.

Available in a wide size range to suit various installations, the feeder can be floor-supported or suspended from cables. Accessories include dust-tight covers, scalping decks and grizzly sections.—**Link-Belt Co., Dept. PR., Prudential Plaza, Chicago, Ill.** **152A**

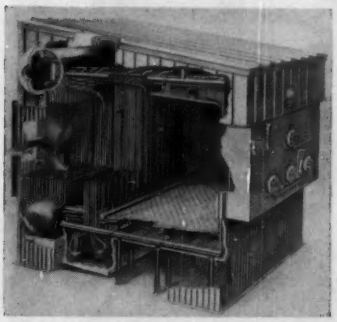
Shipping Container

Fiber drum for shipping handles most liquids.

The Perma-Plex container for shipping liquids combines the strength of steel, light weight of fiber and protective characteristics of polyethylene, according to the manufacturer. Packed product contacts neither metal nor fiber.

Perma-Plex consists of a semi-rigid polyethylene insert

within a 10-ply, Kraft-paper drum. A polyethylene disk also lines the interior of the steel cover. Low in cost, the drums are available in 30- and 55-gal. sizes.—**Permafiber Drum Div., National Steel Container Corp., Chicago, Ill.** 152B



Prefabricated Boiler

Puts out up to 400,000 lb./hr. of steam.

Developed for process, power or heating steam, the new PFI Boiler is available for pressures up to 1,150 psi., and temperatures to 900 F. Pressurized-furnace design results in high efficiency and elimination of induced-draft fans.

The unit features prefabricated construction, which utilizes welded, tubular wall panels. Elimination of internal closure refractory minimizes maintenance. The PFI Boiler will burn either oil, gas or a combination of the two fuels.—**Babcock & Wilcox Co., 161 East 42nd St., New York** 153A

Indicating Controller

Low-cost unit features high-price refinements.

Designed primarily for temperature or pressure control, but adaptable to other process variables, the new Pilot is available to meet industrial needs for a compact, low-cost pneumatic controller. It can provide two-position control and also wide-band proportional control, with or without automatic reset or rate action.

Accuracy of indication is 1% in the middle half of scale, 1½%

for the remainder. Sensitivity is less than 0.1% of full scale at 100% proportional band.—**U. S. Gauge Div., American Machine & Metals, Inc., Sellersville 31, Pa.** 153B

Warning Horn

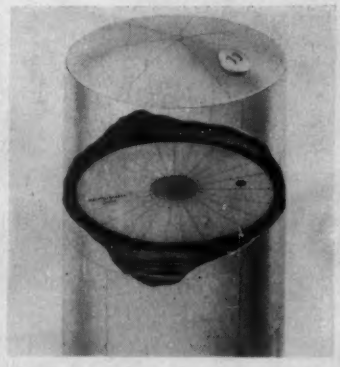
Provides added safety during hazardous work.

Prior to entry into confined hazard areas for cleaning or repair, personnel can give themselves an additional measure of protection by setting the timing mechanism of the Falcon portable horn. In the event of any incapacitation, a released charge of Freon activates a powerful diaphragm horn to alert other personnel in the area that the safe exposure time has been exceeded.

Entirely safe for hazardous vapor areas, the non-electric horn can also be used to assure timely shutoff of equipment. A locking device inactivates the unit when not in use.—**Falcon Alarm Co., Inc., 243 Broad St., Summit, N. J.** 154A

Corrosion control device for water systems consists of a container holding a solid chemical inhibitor. Placed in process equipment, it catches a small quantity of water, which dissolves a controlled amount of the inhibitor, and then releases the water to join the bulk of the stream.—**Water Service Laboratories, Inc., 615 West 131st St., New York 27, N. Y.** 154B

NEW EQUIPMENT . . .



Floating Roof

Plastic cover reduces evaporation losses.

A Hamondflote tank cover is claimed to be capable of reducing evaporation losses for tank-stored volatile liquids by at least 90%. According to the manufacturer, the rigid foam-plastic floating roof will pay for itself within several months of service.

Because it prevents product exposure to air, the polyisocyanate cover offers the additional advantages of safety and product stability. Hamondflote covers, available for tanks up to 20 ft. in diameter, are resistant to all hydrocarbons, water and most chemicals. Supplied in radial segments for do-it-yourself installation.—**Hammond Iron Works, 744 Broad St., Newark 2, N. J. 155A**

BRIEFS

Liquid coolers for winter and summer operation use enclosed modulating dampers that vary air flow to maintain temperature control—even in freezing weather. Capacities to 18-million Btu./hr.—**Niagara Blower Co., 405 Lexington Ave., New York 155B**

Tracing material known as Duratrace is claimed to be superior for engineering drawings and type-on masters. The unique surface on a transparent Mylar base accepts up to 6H pencil. Cost is 15-20% lower than tracing cloth.—**Ozalid Div., General Aniline & Film Corp., Johnson City, N. Y. 155C**

NEW EQUIPMENT . . .

Vacuum dryer, of jacketed conical design, features improved loading hatch, discharge valve, gear motor drive, jacket heating connection and temperature control.—**J. P. Devine Mfg. Co., Pittsburgh 1, Pa.** 156A

Pneumatic relay, which combines two or more signals by multiplication, division, addition or subtraction, is well suited to the ratioing of two flows, or pressure-temperature compensation, during measurement.—**Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.** 156B

Industrial gloves made of Teflon are completely impervious to strong acids and solvents. Available in 12- and 16-in. styles.—**Surety Rubber Co., Carrollton, Ohio.** 156C

Equipment Cost Indexes

	Dec. 1957	March 1958
Industry		
Avg. of all	229.2	231.2
Process Industries		
Cement mfg	220.7	222.9
Chemical	230.4	232.4
Clay products	214.4	216.6
Glass mfg	217.6	219.4
Paint mfg	221.6	223.8
Paper mfg	222.0	223.9
Petroleum ind	226.3	228.6
Rubber ind	229.1	231.4
Process ind. avg	227.0	228.8
Related Industries		
Elec. power equip	232.9	234.2
Mining, milling	231.8	233.8
Refrigerating	258.9	261.5
Steam power	216.9	219.5

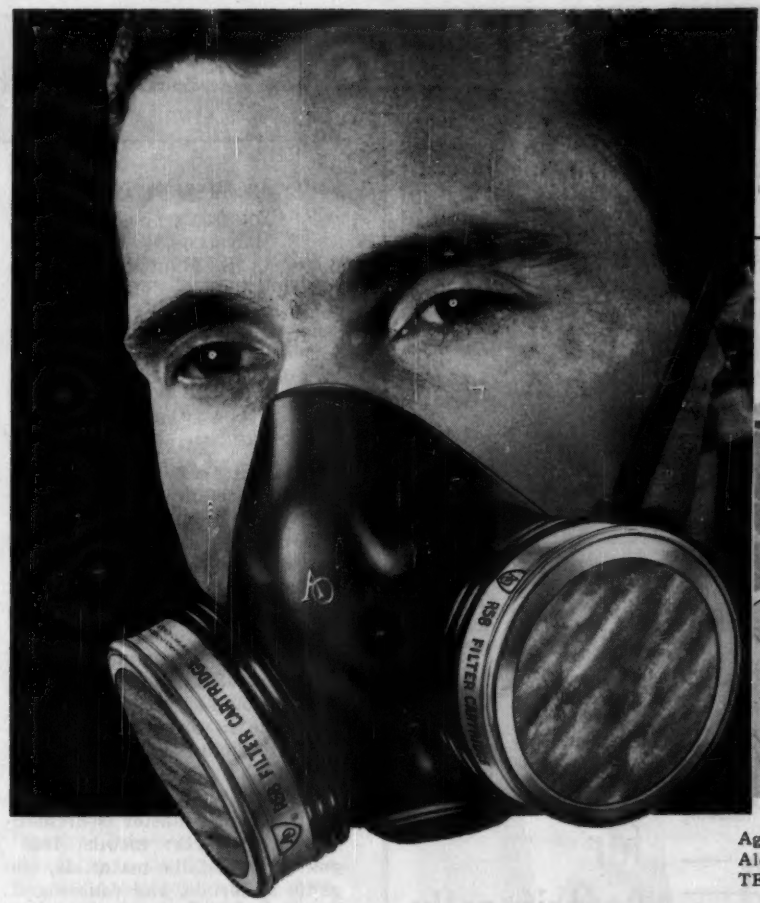
Compiled quarterly by Marshall and Stevens, Inc. of Ill., Chicago, for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124–6 for method of obtaining index numbers; Feb. 24, 1958, pp. 143–4 for annual averages since 1913.

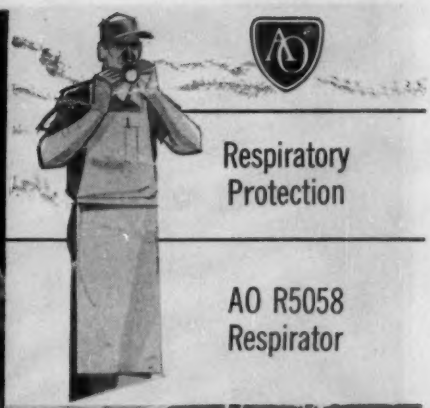
For More Information . . .

about any item in this department, circle its code number on the

Reader Service

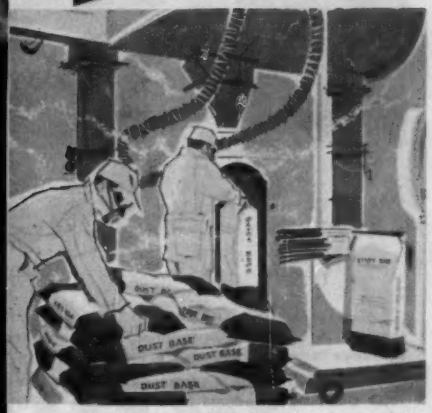
postcard (p. 171)





Respiratory Protection

AO R5058 Respirator



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PEOPLE . . .

TECHNICAL

Unity in Diversity

ENGINEERING MATERIALS HANDBOOK. Edited by C. L. Mantell. McGraw-Hill Book Co., New York. 1,919 pages. $21.50.

Reviewed by Robert V. Jelinek, Department of Chemical Engineering, Syracuse University, Syracuse, N. Y.

Reviewing a book of this kind is almost as difficult as preparing it, for it compiles technical information from so many disciplines that no one reviewer can render expert judgment in all of them.

It is an encyclopedia of facts and figures, prepared by over 150 contributing specialists, which should serve as a valuable reference in materials selection for practicing engineers and students in all branches of the profession.

The subject matter is divided into four parts: metals, inorganic non-metallic materials, organic materials, and causes and prevention of failure. Emphasis is on the fabricated forms of materials—their properties, common uses, advantages and limitations as competitive materials and durability under various service conditions.

Among the salient features noted by this reviewer is the Table of Abbreviations at the beginning of the book. This serves to unify the vocabulary used throughout and to avoid at the outset the confusion that could easily prevail in a volume prepared by so many different authors. Section 1 on the properties of materials, an expanded glossary of basic terms, concepts and processes, aids considerably in orienting the reader in fields unfamiliar to him. Extensive bibliographies are included in most of the sections, and footnote references to basic literature are used throughout. In addition, Section 43 summarizing literature, standards, codes and other sources of information, is a valuable reference work in itself. Section 39 on pipe, valves and fittings, including some of the latest techniques and plastic

BOOKSHELF

J. B. BACON

materials of construction, is of particular interest to chemical process designers.

Relevant to current developments in nuclear technology, data are included on liquid metals and on materials of construction in apparatus for the control and utilization of atomic energy and fission products. New concepts of short-time high-temperature utilization of materials in rockets are contrasted with the demands of long-time high-temperature industrial utilization of metals and refractories.

The chief shortcoming of the book, particularly for use as a teaching text, is the emphasis throughout on technology, with little attention to underlying theories and principles. This is particularly evident in the section on electrochemistry and the several sections dealing with metallurgy. By contrast, the section on corrosion contains a liberal dose of fundamentals and thereby becomes more understandable to the average reader. From the viewpoint of the chemical engineer, another lack is the omission of the chemical industries in Section 42, which discusses materials problems specific to various industries.

These criticisms, however, are not major and should not detract from the overall conclusion that this book is a most worthwhile contribution to the engineering design literature. Dr. Mantell and his collaborators are to be complimented.

BRIEFLY NOTED

PROCEEDINGS OF THE FORTY-FOURTH ANNUAL MEETING OF THE CHEMICAL SPECIALTIES MANUFACTURERS ASSN. *176 pp. Chemical Specialties Manufacturers Assn., 50 E. 41 St., New York 17, N. Y. $7.50 in U. S. and Canada.* Contains complete report of meeting, all papers presented, and committee reports available for publication.

VISCOSITY-TEMPERATURE CHART FOR LIQUID PETROLEUM PRODUCTS. *Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.* $1. Covers a temperature range of —100 F. to 700 F. and a viscosity range from 0.4 to 20 million centistokes.

PEOPLE . . .

MEET YOUR

F. C. Jelen

MAJOR COST ANALYSIS METHODS YIELD EQIVALENT ANSWERS. PAGE 116.

The first article of Fred Jelen's current series on cost analysis talked about the importance of considering "a return on investment." Jelen's next contribution covered "the effect of inflation." After that he came up with his treatment of income tax considerations and last January he tied them all together in one complete article on capitalized cost comparisons.

This current article by Jelen is a comparison of all the different methods of analyzing project costs. He has facetiously labeled this ambitious work his "swan song" in the field.

On a full-time basis, Jelen is a chemist for the Solvay Process Division of Allied Chemical Corp., at Syracuse, N. Y.

George C. Derrick

REDUCE YOUR MAINTENANCE COSTS. PAGE 132.

Olin Mathieson's George Derrick is a process engineer in their

AUTHORS...

M. A. GIBBONS

high-energy-fuels organization. Derrick joined the firm in June 1955 and is doing classified work on the pilot-plant development of high-energy fuels.

George earned his chemical engineering degree from Georgia Tech in 1951, has done graduate work in chemistry at Niagara University and recently received an M.B.A. from the University of Buffalo.

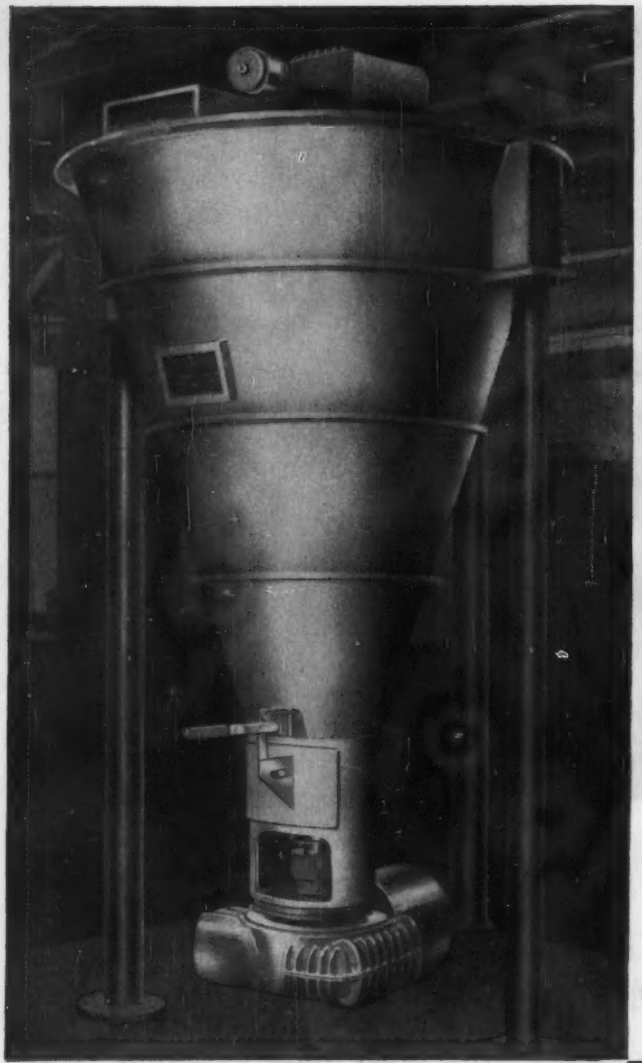
During World War II, Derrick served with the Army in the Pacific. He was, as he puts it, "recalled suddenly to active duty with the Air Force for the Korean Conflict." But he "stayed at home" and served at Wright-Patterson Air Force Base as a project engineer working on high-temperature alloys.

The current article has grown out of George's work at the University of Buffalo. He, like most people that have been exposed to maintenance, feels costs can be reduced. Maintenance costs are often the difference between profit and loss. This has become more important in light of the profit squeeze of recent years and the more recent economic adjustment.

Robert V. Jelinek

CORROSION REFRESHER ON CAUSE AND CURE. PAGE 114.

Now associate professor of chemical engineering, with a side-line as assistant to the dean of engineering for student counseling at Syracuse University, Bob Jelinek has spent most of his professional life in teaching, first at Columbia and now, since



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BLAW-KNOX

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Buflovak Equipment Division
1551 Fillmore Avenue, Buffalo 11, New York

1954, at Syracuse. Columbia awarded him his bachelor's degree in 1945, his master's in 1947 and his doctorate in 1953, all in chemical engineering. The two-year period from 1951 to 1953 he served as a development engineer for Esso Research at Linden, N. J.

His current research specialties include corrosion and mass transfer in liquid metals, specifically lithium, now supported by a National Science Foundation grant. Gas adsorption equilibria and rates, and electroplating of alloys, complete the list. He teaches chemical processes, plant design, corrosion and electrochemistry, kinetics, thermodynamics and unit operations.

Member of AIChE, ACS, ASEE, NACE and numerous other professional societies, he still finds time for his two young sons and for his outside interests of photography, woodworking, music and (sic!) lawn-mowing.

Joseph E. Parker

GAS TURBINES UP PROCESS EFFICIENCY. PAGE 123.

This article is a condensed version of the paper Joseph E. Parker presented at the March 1958 American Power Conference in Chicago. As a member of AIEE and ASME, he has also presented other technical papers and presided over various meetings of these societies.

When he's not presenting papers, Parker heads up the utilities engineering department at the Texas City plant of Union Carbide Chemicals Co. In this capacity, he's responsible for the study, economic evaluation, design, engineering and installation of new facilities. His work

AUTHORS . . .

also includes load and method studies, and improvement programs for existing installations.

A registered professional engineer, Parker has been responsible for the design and installation of two of Carbide's major utilities installations—a high-pressure steam and power plant, and a complete electric power and lighting system. He has also chalked up partial credit for the development of a new kind of polyethylene-insulated high-voltage cable.

Parker, a graduate of the University of Michigan, is very active in community affairs. An Elder of the local Lutheran Church, he is or has been active in the Boy Scouts, PTA, Civil Defense and other organizations.

Fred J. Poss

WHAT YOU CAN DO TO REDUCE STRESS CORROSION. PAGE 140.

Don't let Fred Poss' title of metallurgist fool you. He is a practical materials-of-construction man with a solid background in chemical engineering.

After getting a BS in chemical engineering from Wayne University in 1938, Poss spent the next six years in the Army. After his discharge he went back to school, this time to Michigan College of Mining and Technology, and received his MS in 1947.

He then joined Du Pont in Niagara Falls as a research and development engineer. After eight years of this, atomic energy beckoned. Poss joined AEC.

Poss is now service metallurgist in U. S. Steel's stainless metallurgical group, Pittsburgh, Pa. He does a lot of trouble-shooting on stainless, particularly in the chemical industry.

Gerald A. Lessells

HOW TO MAKE AND USE MORE EFFECTIVE GRAPHS. PAGE 109.

In his work as a research and development engineer, Gerry Lessells became increasingly impressed with the usefulness of graph paper as a tool of the chemical engineer. Every engineer, reasoned Lessells, knows the ordinary uses of ordinary papers—but does he know the special uses and the special papers? Fortunately for us (and for you, the reader) the upshot of this speculation was a survey which expanded into this two-part article.

Lessells is a project leader at the Cincinnati research center of National Distillers & Chemical Corp.'s U. S. Industrial Chemical Division. From mid-1950 until April 1957 he was with Mathieson Chemical and Olin Mathieson, first at Niagara Falls on chemical engineering development, later at Brandenburg, Ky., as a project leader on petrochemical development. His specialties include bench and pilot-scale systems, the carrying out of experimental programs, the evaluation and correlation of data, the application of kinetics to data correlation and design.

Following a wartime Army stint, Lessells acquired a 1950 BS in ChE from MIT, simultaneously acquiring a wife and, subsequently, three sons. In addition to his hobbies of amateur astronomy, wood working and reading, Lessells likes to write, a fact that is attested by two Plant Notebook prizes, a Design Notebook feature, and his article of a year ago on the rapid evaluation of kinetic data.

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Chemicals

Acetylene Derivatives.....6 p. brochure outlines properties and uses of high-pressure acetylene derivatives. Uses of these products for products ranging from cosmetics to paints.
166A Antara Chemicals

Aluminas.....Information and prices on activated aluminas in two standard mesh sizes: 100 to 200, and −200. Application notes on properties of chromatographic alumina.
166B Bio-Rad Laboratories

Antifoams.....3 p. information sheet describes new antifoams, when and how to use them, what quantities to use, general theory. Antifoams come as liquid, flake, powder.
166C Hodag Chemical Corp.

Blowing Agent.....Bulletin PKB-1 covers use of hydrazine-derived blowing agent in natural and synthetic rubber. Bulletin PKB-2 cover use in plastics.
166D National Polychemicals, Inc.

Ceramics....."Low-Temperature Glasses as Bonding Materials for Crystals" is a 4 p. booklet including data on the mechanical and physical functions of glasses.
166E Lead Industries Assn.

Chemicals, Fine.....Price list for 1958 covers 170 products used in biochemical and medical research and as intermediates in food and pharmaceutical manufacturing.
166F Schwarz Laboratories, Inc.

Coating.....Reflective coating for asphalt is described in 6 p. bulletin. Chemical resistant properties, physical properties, colors for light reflection are included.
166G Durosel, Inc.

Crotonic Acid.....Reactions, properties and applications are described in 8 p. brochure. Suggests use as an intermediate in making molding polymers, protective coatings.
166H Eastman Chemical Products

• From advertisement, this issue

LITERATURE

E. M. FLYNN

Electrochemicals.....new booklet offered on silicon compounds & other electrochemicals brings you valuable data on how to add quality & profit to your production.
R155 *Norton Co., Electrochem. Div.

Fine Chemicals.....12 p. 1958 domestic catalogue list 44 different products, 5 of which are new additions. Company can carry on Grignard synthesis for customers on special order.
167A Arapahoe Chemicals, Inc.

Hydrogen Peroxide, Solvay.....Complete information on diluting. For facts on handling, storing etc. send for data book, "Dilution of Hydrogen Peroxide."
75 *Allied Chem., Solvay Proc. Div.

Metal Cleaner.....Two bulletins describe new material for cleaning and light phosphating of iron, steel, zinc. No. 108-12 is on spray washer operation, 108-13 on dip tank.
167B Turco Products, Inc.

Ozone.....Theoretical monograph on organic ozone reactions and techniques. Discusses mechanisms and various linkages, functional groups and nucleophilic centers attacked by ozone.
167C Welsbach Corp.

Pentaerythritol.....A new prescription for plants processing with Pelletized PE. Handles easier—in transit—in storage—and actually helps to shorten cooking time.
71 *Celanese Corp. of America

Pesticides.....“Hydrides for Pesticide Chemistry,” 2 p., gives, for each hydride reaction: function of hydride, solvent used, equation, reviews principal application.
167D Metal Hydrides Inc.

Plastics, Reinforced.....16 p. catalog and price list of materials for fibrous glass reinforced plastics as stocked by nation's largest distributor.
167E Cadillac Plastics & Chemical

Polyethylene.....“Molder's Guide to Injection Molding Grex High Density Polyethylene” gives recommendations for part and mold design and molding machine selection.
167F W. R. Grace & Co.

Contents of This Issue

* From advertisement, this issue

LITERATURE . . .

Mercurials.....If your process problems involve industrial mercurials with controlled physical form, uniformity & high standards of purity, write for information.
147 *Mallinckrodt Chemical Works

Resins, Fluorocarbon ..... Write for engineering data and examples of how they can be applied to improve chemical and petro-chemical processes.
95 *DuPont, Polychemicals Dept.

Solvents, Aromatic ..... Covering a wide range of evaporation rates. Sol 53 & TS-28 for baking finishes & flow coating. Write for booklet describing typical properties.
59 *Shell Oil Company

Sulphur ..... Stockpiling has always been a company policy. This enables routine or emergency shipments at any time, by any method, of any tonnage.
27 *Texas Gulf Sulphur Co.

Titanium.....Combines unique corrosion resistance with high strength-weight-ratio. Booklet gives cost saving service records . . . tells where you can get mill products.
133 *Electro Metallurgical Co.

Construction Materials

Alloys.....Newly published booklet describes Hastelloy alloys—unusual resistance to hot mineral acids, strongly oxidizing salts, and powerful gaseous oxidants.
141 *Haynes Stellite Co.

Aluminum ..... Eliminates corrosion with process equipment, pipes & tubes, tanks, truck & cars, and plant structures of aluminum. Process industries can benefit.
24 *Aluminum Co. of America

Castings, Alloy.....to insure uniform, non-porous castings in special shapes . . . special finishes, for your particular requirements.
R174 *Kennedy Van Saun

Coatings.....sprays seamless pore-free lining. Outstanding resistance to abrasion, absolutely corrosion resistant. Vinyl material. Bul. Chem-C-3.
42 *Metal & Thermit Corp.

Hydrated Aluminas....widely used in the production of petroleum cracking catalysts, as an adsorption agent in ceramics and roofing granules. Booklet available.
39 *Reynolds Metals Co.

Linings, Plastic.....Fluorocarbon linings offer the way to make any ordinary equipment & piping extremely resistant to acids, alkalies & solvents. Bul. AD-152.
161 *U. S. Gasket Co.

Metallic Medium ..... for filtration, straining, distribution & dispersion. Lasts longer in pressure leaf filters, filter presses, centrifugals & Ion exchange towers.
B181 *Multi-Metal Wire Cloth Co.

Nickel, Inco.....Consider nickel-containing stainless steels for your corrosion problems. Resistant to a wide range of organic & inorganic chemicals. Booklet avail.
67 *International Nickel Co., Inc.

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LITERATURE . . .

Solvents.....Unsurpassed for uniformity and purity, Solvesso 100 sets performance standards throughout paint & surface coating industry. Reliable supply & delivery.
65 *Esso Standard Oil

Steel, Aluminized.....Produced in two grades which provide a range of useful properties at low cost. Both have good heat reflectivity plus resistance to fire damage.
104 *Armco Steel Corp.

Steel, Glassed..... Greater insurance against unexpected or unavoidable shock with Glasteel 59. Offers excellent acid resistance. Send for our new Buyer's Guide.
4th Cover *The Pfaudler Co.

Titanium..... Write for bulletin on corrosion resistant properties of titanium. Titanium liners & dip-tubes win over stainless steel shells and flanges.
44 *Mallory-Sharon

Wire, Stainless Steel.....Manual now available for your particular application or prod. problem. Filters, screens and many types of screws. Send for your copy.
26 *Jones & Laughlin Steel Corp.

Electrical & Mechanical

Casters.....with phenolic wheels will stand temperatures up to 200 F . . . non-marking . . . quieter rolling . . . no rusting or corroding. Wheels have beveled edges.
L174 *Darnell Corp.

Couplings..... for safe transfer of chemicals get Ever-Tite quick couplings. Efficient & economical service, whatever the need.
TL-182 *Ever-Tite Coupling Co., Inc.

Cutters, Knife.....The 700 series are unique in their combination of multiple knives, high speed & shearing cut. Main bearings available in different types. Bul. 216.
169A Taylor, Stiles & Co.

Flexible Drive..... Catalog describes press-on type and interchangeable-hub designs of flexible drive couplings. For shafts from ⅜ to 6-in. size.
169B Detroit Power Coupling

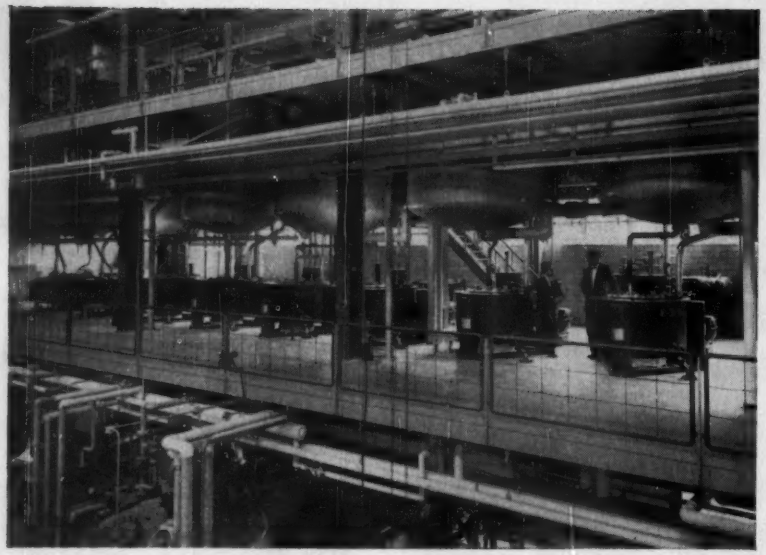
Head Press.....Precision machine is capable of hot or cold pressing in a variety of metals. This aids in production of manhole fittings, steel products etc.
33 *Colorado Fuel & Iron Corp.

Insulation, Ceramic.....for measuring all types of process temperatures. Provides an increase in thermocouple life over conventional, open-end types. Bul. 325-E.
B180 *Thermo Electric Co., Inc.

Motors.....For any drive requirements with power drive features, speeds installation and construction. Ratings—⅛ to 400 H.P. All phases, voltages and frequencies.
Third Cover *Master Electric Co.

Motors, Electric.....Reference folder lists geared and non-geared electric motors from 1/2,000 to 25 hp. Complete prices and electrical information included.
169C B & B Electric Motor Co.

* From advertisement, this issue



LITERATURE . . .

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T181 *R. D. Cole Mfg. Co.

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40 *Graver Tank & Mfg. Co., Inc.

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174B Automatic Transportation Co.

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174C Clark Equipment Co.

Scales.....Weighing is a vital element in your overall cost control system. New Toledo Weight Fact Kit will help you determine how well your scales measure up.
88 *Toledo Scale Div.

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174D *Richardson Scale Co.

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B179 *Niagara Blower Company

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46 *Leeds Northrup Co.

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174E Harold L. Palmer Co.

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52 *Patterson-Kelly Co.

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47 *Link-Belt Co.

Dryers ..... Whether your plans include a dryer, cooler or kiln . . . let Standard-Hersey engineers help you with your processing problems. Learn results in advance.
B182 *Standard Steel Corp.

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63 *National Carbon Co.

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23 *Allis-Chalmers

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61 *Foster Wheeler Corp.

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150 *Clayton Manufacturing Co.

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20-21 *De Laval Separator Co.

Heat Exchangers, Plate..... Booklet describes installation, operation and maintenance of manufacturer's line. Include proven applications and distinctive features.
175A De Laval Separator Co.

Heat Exchangers, Pyrex.....are light & easily handled . . . simple to install & maintain. Sediment build up is small, can be flushed out. Bulletin gives information.
177 *Corning Glass Works

Heaters, Dielectric.....Cut costs, save space, speed production with dielectric heaters. Available in a complete range from 3 kw to 100 kw. Bulletin 15B6431C.
99 *Allis-Chalmers.

Heaters, Fired.....Trouble-free service, high thermal efficiency & highest temperatures & pressures. Many units supplied to petroleum & petro-chemical industries. Bul. A-46.
45 *Struthers Wells Corp.

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30 *Traylor Engineering & Mfg.

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TR182 *Dean Thermo-Panel Coil Div.

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R175 *Yarnall-Waring Co.

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77 *Chicago Apparatus Co.

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175B Cambridge Instrument Co.

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Controller, Pressure.....Designed for installation where desirable to change outlet pressure & maintain without variation set outlet pressure. Bulletin No. 5000.
176A Norwalk Valve Co.

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37 *Industrial Nucleonics Corp.

Dewpointer.....only instrument that lets you see the fog in a sealed chamber under controlled conditions. Available in three ranges. Bulletin is offered.
L175 *Illinois Testing Lab.

Instruments, Electronic Measuring..... Catalog WK-01 describes a wide variety of control and laboratory measurement instruments designed for accuracy and facility.
176B Wayne Kerr

Lubricating System.....miniature size for limited space . . . complete with pump, metering valves & controls. Adaptable to light, multiple-bearing machines.
73 *Alemite

Meters, Gas.....One of our meters often replaces two or three of other types thus cutting costs. Assure unalterable accuracy. For details, request. Bul. M-152.
165 . *Roots-Connersville Blower

Recorders.....On a single chart you can measure four variables with a Bailey receiver recorder. Interchangeable receivers permit new combinations. Booklet E12-5.
86 *Bailey Meter Co.

Regulator, Voltage.....Unit automatically regulates fluctuating a.c. power lines to maintain a constant output voltage regardless of line or load changes.
176C Superior Electric Co.

Thermometers, Industrial.....Catalog No. 125A contains pertinent engineering data about the units. Also available, Catalogs: 225A, 325A, 425A, and 525A. New & revised.
176D Weksler Thermometer Co.

Transmitter, Potentiometer.....custom equipped for your specific application. Available from shelf-stock. High order of linearity and accuracy. Catalog 98262.
96 *Taylor Instruments

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Castings, Pipe.....high resistance to corrosion or extreme heat. Strength comes from exceptionally uniform dense grain structure . . . will meet your specifications.
159 *Duraloy Company

Equipment, Rubber & Plastic.....fittings, valves & linings in high-impact, rubber-plastic. Economical & insensitive to crrosives. Write for information.
148 *American Hard Rubber Co.

Fittings, Stainless Steel ..... New standards of sanitation for drug laboratories. Our engineering staff will help you to solve corrosion-resistant piping problems.
97a *Ladish Co.

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Fittings.....Request your catalog today on stainless steel fittings . . . three big reasons why: easier alignment, leakproof union joints, flange without welding.
81 *Horace T. Potts Co.

Fittings, Welding ..... Your corrosion piping system can be designed better and assembled faster with Flowline fittings. Available with plus values at no extra cost.
6 *Welding Fittings Corp.

Flanges.....New, light weight, forged steel flanges cut costs. Maximum service pressures are the same as for cast iron flanges.
Second Cover *Tube Turns, Div. of Chemetron Corp.

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145 *United States Rubber

Pipes, Plastic.....For corrosive chemicals and gases of all types. Nine different kinds . . . with fittings and valves to match. For details, Bulletin CE-50.
149 *American Hard Rubber Co.

Pipes.....For price, quality and dependable delivery. Write for 16-page illustrated brochure for the complete story of Flori-Houston fabrication team.
83 *The Flori Pipe Co.

Pipe & Fittings.....are immune to the corrosive action of most acids, liquids and gases. Smooth interior walls minimize built-up of deposits, assuring free-flow.
T179 *Mueller Brass Co.

Pipe & Tubing, Stainless Steel.....A completely equipped plant able to offer stainless steel tubing in a range of A.I.S.I. analyses plus special alloy grades. Catalog.
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38 *Nicholson & Co.

Tubing, Stainless ..... Eight-page folder explains how the use of the right stainless steel mechanical tubing results in savings. Includes dimension tables. TB365A.
177A Babcock & Wilcox Co.

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143 The Duriron Co., Inc.

Valves.....All kinds and types available in variety of metals & alloys. Able to handle every flow control requirement. For special engineering problems write direct.
139 *Wm. Powell Company

Valves.....New general purpose gate & globe valves with seal welded bonnet joints. Both series identical in dimension & have chrome stainless steel trim.
131 *Henry Vogt Machine Co.

Valves, Ball ..... Double-Seal ball valves handle a wider range of liquids and gases. They take care of acids, abrasives, chemicals, solvents, etc. Literature.
154 *Jamesbury Corp.

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Valves, Bronze Globe.....Install this plug type Valve, made for maximum wear in valve-killing service in close-control steam service. Folder 189B.
89 *Jenkins Bros.

Valve Operator.....Advantages of a new planetary gear operator—for use with manufacturers valves—are described in Bulletin V-610. Send for your copy.
178A Rockwell Mfg. Co.

Valves, Safety Relief.....Two-ply stainless steel sealing bellows in safety relief valves isolates contaminants, corrosion or viscous fluids from working parts. Cat. 1900.
92 *Manning, Maxwell & Moore.

Valves, Steam-Jacketed.....For handling viscous liquids. Non-sticking because of its protected-seat design. No lubricant used—this saving maintenance cost.
98 *Wedgeplug Valve Co.

Valves, Temperature Control.....New plastic-coated sensing bulb and thermal system is now available with all sliding-gate temperature control valves. Bul. J-180.
178B OPW Corp.

Valves & Fittings.....User experience proves dependability under toughest conditions. Send for free copy of "Valve Performance Facts", for examples of savings.
105 *Crane Company

Process Equipment

Belts, Wire.....used in the chemical industry for bagging cement, drying wool, tanning hides, processing rubber etc. Combine movement with processing. Reference Manual.
164 *Cambridge Wire Cloth Co.

Centrifugals..... Batch-Master's fast bottom discharge and hydraulic unloading make the difference in labor requirements & in batch processing cycle time.
170 *Tolhurst Centrifugals

Centrifugal Separator.....Can handle the basic separations . . . concentration, clarification, washing, soluble recovery and classification. Write for details.
54-55 *Dorr-Oliver Inc.

Centrifuges..... Greater capacity for solids dewatering. If a solids dewatering step is necessary in your processing, it will pay you to get the facts. Write today.
14-15 *Sharpless Corporation

Dissolvers..... High quality metallic dispersions can easily be controlled and produced in big volume, using new dissolver. Technical Bulletin 21-1957.
35 *Morehouse-Cowles Inc.

Equipment, Dust Control.....proved in countless applications. Airstream conveyors and filters are effective allies in the fight against air pollution. Bul. 800.
34 *Dracco Div. of Fuller Co.

Filter, Centrifugal.....Covers the widest range of solid-liquid separations. The solid bowl cannot blind as a result of salting out of hot saturated liquids.
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Dryers, Spray ..... Informative brochure shows the advantages of spray drying processes. Gives detailed description of the latest installations.
179A Swenson Evaporator Co.

Dust Precipitator.....Now offered in a new design which operates at face velocities of up to 600 ft./sec., the Electro-cell features sectional construction.
158C American Air Filter Co.

Filter Fabrics ..... Always ready to lend a hand in solving your filter cloth problems. Complete line of filter fabrics in nylon & cotton. Request booklet.
36 *Wellington Sears

Filter media.....chemical fiber Windsor felts offer high efficiency particle retention. Eliminate the use of secondary dressing materials. Data Sheet #18.
R169 *American Felt Co.

Filter Presses ..... Company's filter presses are available in designs and capacities to handle any filterable mixture and any filter material. Catalog.
167 *D. R. Sperry & Co.

Filters.....Fulflo filters for water and aqueous liquids . . . with genuine honeycomb tubes for true depth filtration. Bulletin GEO-501 gives full information.
179B *Commercial Filters Corp.

Filters, Dust ....."Roll-Clean" Dynaclone self-cleaning, continuously operating dust filter is described in 36-page Bul. 104. Complete dust seal, easy filter bag changing.
178 *W. W. Sly Mfg. Co.

Filters, Water.....Where high quality process water is needed, diatomite filter provide an effluent second only to distilled water. Bul. 651 & Bul. 909 give details.
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2—Fitzpatrick Model D-6 Stainless Steel Comminuters, also Model D-3.
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2—J. H. Day size G 2000 lb. Ribbon-type Powder Mixers, split spiral type Agitator.
Mikro Pulverizers, Models 1SH, 2TH, 3TH and 4TH.
3—Lancaster Model EMG-4 Counter Current "Close Tolerance" Rapid Batch Mixers.
Baker Perkins, Day, W&P Heavy Duty Mixers, 12 to 150 gal. caps.
4—Stokes & Smith Model G1, G2, G4, HG84, HG87, and HG88 Auger Powder Fillers.

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Crystallizers: 500 gal. stain. steel, jacketed.
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Kettles: St. steel, with and without ag.
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Mills: Mikro Bantam, 2TH and 24".
Jeffery 30 x 24" type A.
Fitz Comminuting model D, st. st.
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6—Pfaudler Series R glass lined jacketed reactors, 1000 gal. Each.
1—Louisville S.S. rotary kiln, 30" x 28'

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1—Tolhurst 26" suspended type centrifuge, complete with motor, perforate basket.
1—AT&M 42" suspended type centrifuge, complete with type 347 S. S. perforate basket, plow and curb, with 40/20 HP motor.
1—Tolhurst 32" suspended type centrifuge with imperforate basket.
1—Tolhurst 40" center slung centrifuge with rubber covered perforate basket.
2—Tolhurst 48" center slung centrifuge with rubber covered perforate basket.
1—Baker Perkins Type 316 S. S. Ter Meer centrifuge, Model HS-24".

DRYERS:

4—Link Belt steel roto louvre dryers, Models 207-10, 310-16, 310-20, 604-20.
1—Buflovak double drum dryer, 42" x 120".
1—Stokes Model 59DS, steel rotary vacuum dryer, 5' x 30'.
1—Bartlett & Snow rotary dryer, 4'6" x 36'6".
1—Stokes double drum dryer, 5' x 12'.
1—Louisville rotary steam tube dryer, 8' x 45'.
1—Stokes S. S. rotary vacuum dryer, 2' x 6'.

FILTERS:

1—Oliver horizontal filter, 6'6".
1—Feinc S. S. rotary string filter, 3' x 3' (NEW).
1—Oliver horizontal 3' pilot plant filter (NEW).
1—Sweetland #7 filter with 20 steel leaves.
10—Sweetland #12 filters with 72 S. S. leaves.
1—Sperry aluminum plate and frame filter press, 42" x 42", 33 chambers.
1—Sweetland #3 S. S. filter.
1—Niagara S. S. filter Model 510-28.
1—Shriver Cast Iron 30" x 30", 4 eyed closed delivery filter press, 32 chambers.

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1—Acme Type 316 S. S. reactor, 2000 gal.
1—Walter 500 gal. S. S. jacketed kettle.
5—Pfaudler glass lined jacketed reactor, 125 to 300 gal.

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1—Davis Eng. Type 316 S. S. bubble cap column, 8" x 18' with 30 plates.
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2—Blaw Knox Distillation Units, 3' x 40' complete.
2—Stokes Model "T" tablet presses.

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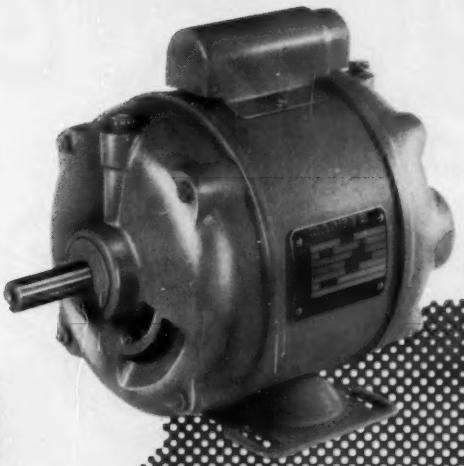

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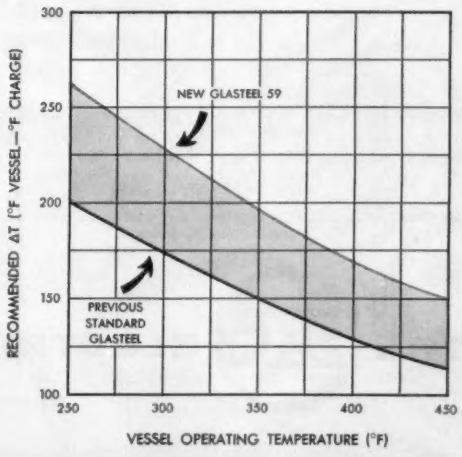

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